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INTERIM GUIDANCE EVALUATION OF SCHOOL SITES WITH POTENTIAL SOIL CONTAMINATION AS A RESULT OF LEAD FROM LEAD-BASED PAINT, ORGANOCHLORINE PESTICIDES FROM TERMITICIDES, AND POLYCHLORINATED BIPHENYLS FROM ELECTRICAL TRANSFORMERS Revised 06/09/06

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1.0 PURPOSE

This guidance is intended to provide a uniform and streamlined approach to initially evaluate proposed school sites where lead from lead-based paint, organochlorine pesticides (OCPs) from termiticide application, and polychlorinated biphenyls (PCBs) from electrical transformers are potential sources of soil contamination. This guidance is not a substitute for professional judgment, supported by technical justification and rationale, of qualified environmental professionals. The purpose is to evaluate the potential soil contamination by lead, OCPs, and PCBs and determine if these levels pose a threat to human health.

This guidance is only intended for evaluating sites for potential human health concerns associated with direct exposure of humans to contaminants in soil through incidental soil ingestion, dermal contact, and inhalation of dust in outdoor air. The screening values contained herein do not consider impact to groundwater or address ecological concerns. If site information indicates that other exposure pathways may be complete or the environment (non-human biota or habitats) may be impacted, a more detailed evaluation should be conducted in consultation with DTSC in a Preliminary Environmental Assessment (PEA). If a school district is unclear or has questions regarding exposure pathways for the site or whether the site can be adequately addressed by this guidance, DTSC should be consulted.

If DTSC determines that results of sampling described in this guidance indicate that a contaminant may pose a risk to human health or the environment, DTSC may require additional characterization of the nature and extent of contamination in a PEA or Supplemental Site Investigation (SSI) (Ed. Code, § 17213.1, subsecs. (a)(4)(A) and (a)(10)).

This guidance supersedes the *Interim Guidance for Evaluating Lead-Based Paint and Asbestos-Containing Materials at Proposed School Sites* (DTSC 2001). The school district is responsible for complying with federal, state, and local requirements for mitigation, management, or removal of asbestos-containing material (ACM). Although DTSC will no longer provide guidance for specifically for ACM found in buildings and structures, DTSC will continue providing guidance for naturally-occurring asbestos.

2.0 BACKGROUND

Education Code sections 17210, 17210.1, 17213.1, and 17213.2, specify a comprehensive environmental review process under DTSC oversight for proposed new or expanding schools. Consistent with the Education Code, DTSC utilizes a three-step process for environmental review of school sites (1) Phase I Environmental Site Assessment (Phase I), (2) PEA, and (3) additional investigation and, if necessary, response action. The role of DTSC is to ensure protection of children, staff, community, and the environment from the potential harmful effects of exposure to hazardous materials.

To expedite the environmental review process and allow school districts to focus resources where they are most needed, regulations for Phase Is became effective on February 10, 2003 (Cal. Code Regs., tit. 22, div. 4.5, ch. 51.5, commencing with § 69100, as amended). The regulations enable school districts to submit limited soil sampling data for specific contaminants at a site in a Phase I or Phase I Addendum.

3.0 USE OF GUIDANCE

This guidance provides recommended sampling strategies, sample analyses, and health screening criteria for lead, OCPs, and PCBs. The information in this guidance may be used for investigations conducted as part of the environmental review process for school sites.

The Phase I regulations (Cal. Code Regs., tit. 22, div. 4.5, ch. 51.5, commencing with § 69100, as amended) should be consulted to determine whether sampling results may be submitted in a Phase I or Phase I Addendum. If sampling results are included in a Phase I or Phase I Addendum, submittal of a work plan for DTSC review and approval is not necessary if the strategies described herein are followed. However, if a school district prefers, DTSC is available to help develop a site-specific sampling strategy using this guidance before sampling at a site.

DTSC should be consulted for sites not addressed by this guidance or with deviations from the strategies described herein. If a school district is unclear or has questions as to whether their site can be adequately addressed by this guidance, DTSC should be consulted. Based on specific characteristics of a site, DTSC may recommend submittal of a work plan prior to conducting sampling activities. If evaluation of lead, OCPs, or PCBs from specific sources, as described, is conducted as part of a PEA or SSI, the strategies herein may be incorporated into an associated work plan.

In general, all potential contaminants associated with a site should be evaluated at the same time. When pre- and post-demolition strategies are presented, sampling should be conducted prior to demolition or renovation of structures (pre-demolition) since activities that disturb soil may spread contamination, if present. However, post-demolition sampling strategies are provided if circumstances beyond the control of the school district make pre-demolition sampling impractical. A consistent sampling strategy (either pre- or post-demolition) should be used for the entire site, even if it consists of multiple parcels. DTSC understands that sampling may become cost prohibitive for sites consisting of multiple parcels and is available to discuss adjustment to the number of sampling locations and samples recommended herein for such sites.

Screening values presented in the guidance are for initial assessment only and should not be construed as a required removal or remedial levels. If a response action is required for a school site, removal or remedial levels will be evaluated and approved by DTSC through a removal action work plan or remedial action plan.

4.0 LEAD FROM LEAD-BASED PAINT

Lead can impair the nervous system, affecting hearing, vision, and muscle control. Lead is also toxic to the kidneys, blood, and heart. Exposure of children to lead may cause irreversible learning deficits, mental retardation, and delayed neurological and physical development (ATSDR 1999).

In response to the potential harmful effects from lead, the United States Consumer Product Safety Commission (U.S. CPSC) banned the application of paint containing more than 0.06 percent (600 parts per million) lead by weight on residential structures in 1978 (DHS 1998, CDC 1991, U.S. CPSC 2005, and U.S. EPA 2004b). However, surplus lead-based paint was still used for more than a decade later and lead-containing paint (paint with a detectable amount of lead) is still available for industrial, military, and marine usage (DHS 1998 and CDC 1991).

Considering the U.S. CPSC action, California Code of Regulations, title 17, section 35043 defines presumed lead-based paint as “paint or surface coating affixed to a component in or on a structure, excluding paint or surface coating affixed to a component in or on a residential dwelling constructed on or after January 1, 1979, or a school constructed on or after January 1, 1993.”

Based on this information, structures with paint or surface coatings, with the exception of residential structures constructed on or after January 1, 1979 or schools constructed on or after January 1, 1993, may have surfaces coated with lead-based paint. As a result, any commercial or industrial structures, regardless of construction date, may have surfaces coated with lead-based paint.

Abatement, mitigation, and management of lead-based paint on building surfaces are currently regulated by several federal, state, and local agencies. However, evaluation of potential lead contamination in soil is part of the environmental review process for school sites under DTSC oversight (Ed. Code, § 17213.1). Weathering, scraping, chipping, and abrasion may cause lead to be released to and accumulated in soil around these structures. If the site historically included or currently includes structures with potential lead-based paint, soil sampling for lead in soil should be conducted. A decision tree to evaluate whether lead in soil from lead-based paint may be a concern is provided in Figure 1. If a lead inspection was performed, it may be submitted for DTSC to evaluate in conjunction with site-specific information to determine if lead in soil sampling may be a concern.

4.1 Soil Sampling

A decision tree to select the appropriate sampling strategy for sampling for lead in soil from lead-based paint is provided in Figure 2, and details for pre- and post-demolition sampling strategies are provided in the following sections. The pre-demolition sampling strategy may also be used to evaluate existing structures with potential lead-based paint that will remain on site and be incorporated into the school.

FIGURE 1
Determining If Lead in Soil is a Concern

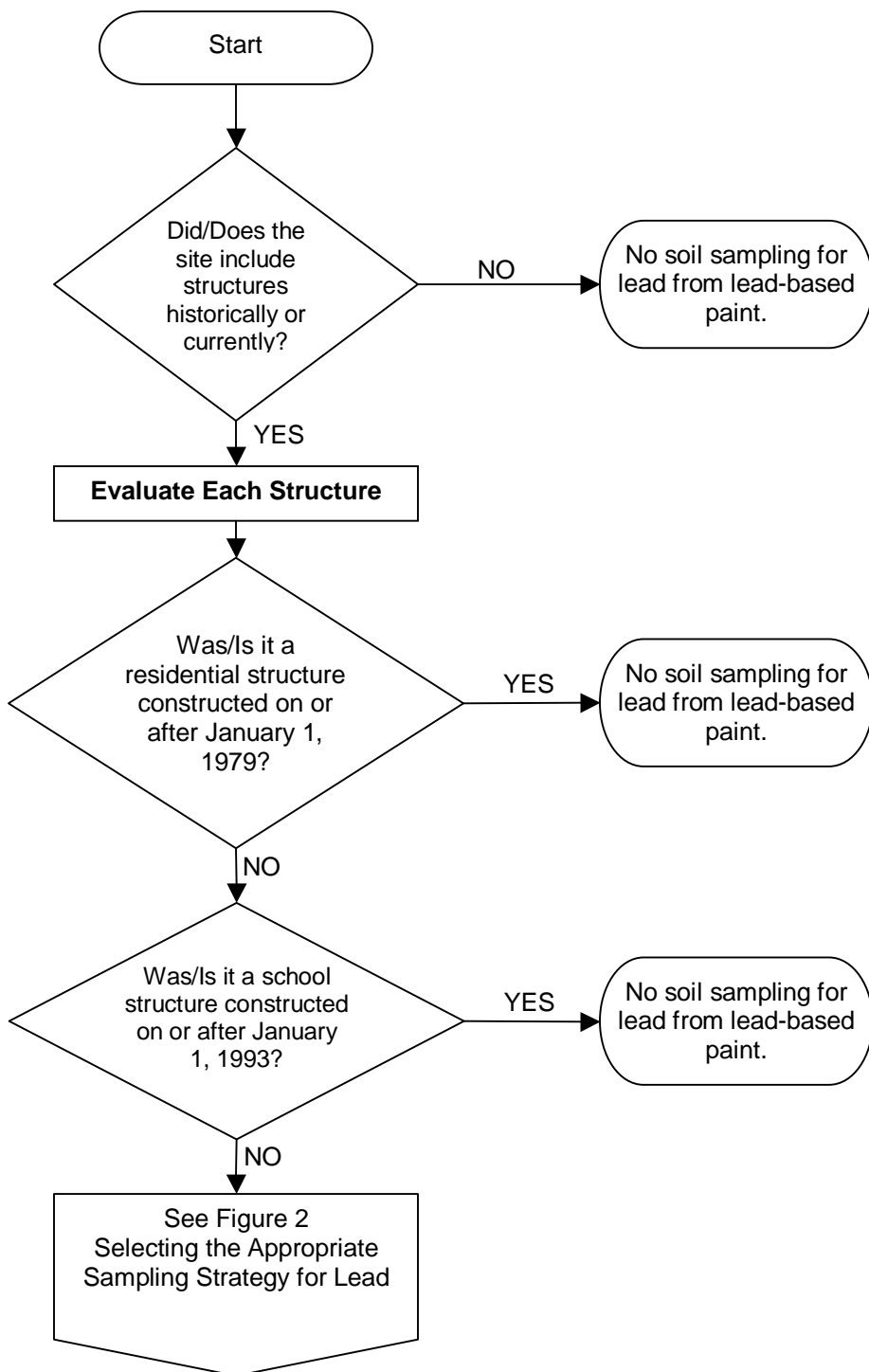
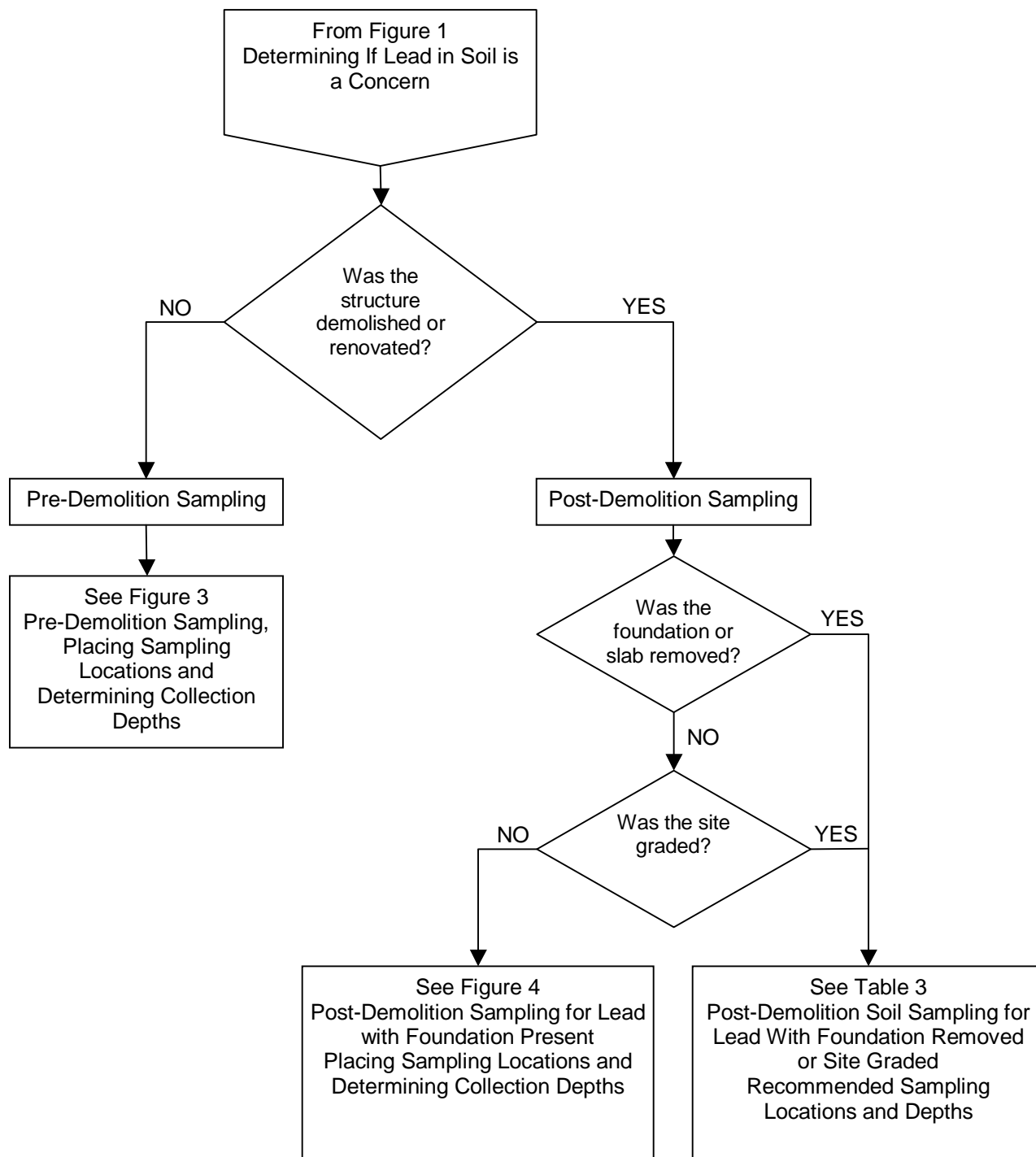


FIGURE 2
Selecting the Appropriate Sampling Strategy for Lead



4.1.1 PRE-DEMOLITION SAMPLING

A visual inspection of the site is useful to determine the presence, location, and extent of deteriorated paint. Any observations should be used to focus soil sampling around structure perimeters in areas with the highest potential for lead deposits.

The recommended number of sampling locations may vary depending on the type and number of structures, and conditions found. Table 1 provides a recommended minimum number of sampling locations for pre-demolition sampling. In general, more samples are recommended as the surface area of the structure increases.

Sampling locations should be distributed around the perimeter within two feet of the structure. If concrete or asphalt borders the structure, sampling locations should be placed in the nearest unpaved areas where associated runoff may collect. Additional sampling locations may be used to evaluate potential releases of lead beneath adjacent concrete or asphalt placed after the structure was constructed. Discrete surface (zero to six inches below ground surface) soil samples should be collected from each sampling location. A decision tree is provided in Figure 3 for sampling location placement and sample collection depths.

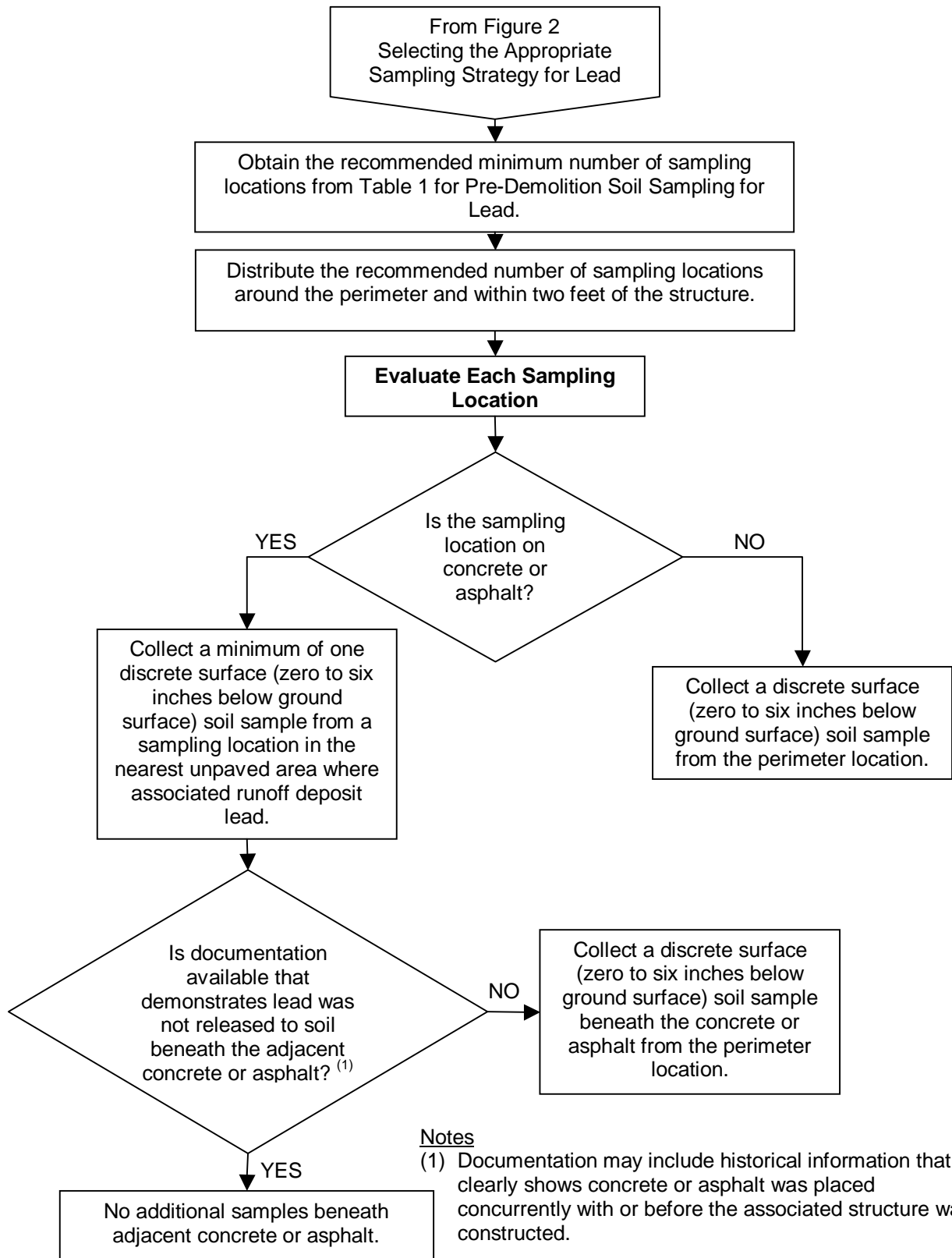
TABLE 1
Pre-Demolition Soil Sampling for Lead
Recommended Minimum Number of Sampling Locations

Structure Type	Recommended Minimum Number of Sampling Locations ⁽¹⁾
Single-family housing, multi-family housing (up to and including four units), or detached carports/garages	Four locations for each structure.
Out buildings (shed or similar small structures)	Two locations for each structure.
Multi-family housing (more than four units), commercial structures, or barns	Six locations for each structure.

Notes

- (1) Additional sampling locations may be used to evaluate potential releases of lead beneath adjacent concrete or asphalt placed after the structure was constructed. Refer to Figure 3 – Pre-Demolition Sampling, Placing Sampling Locations and Determining Collection Depths.

FIGURE 3
Pre-Demolition Sampling
Placing Sampling Locations and Determining Collection Depths



4.1.2 POST-DEMOLITION SAMPLING

Two post-demolition (structure has been demolished or renovated) sampling strategies are provided for conditions that may be encountered on a site:

- Foundation Present (Section 4.1.2.1)
 - Foundation present and site not graded.
- Foundation Removed or Site Graded (Section 4.1.2.2)
 - Foundation present and site graded.
 - Foundation removed and site not graded.
 - Foundation removed and site graded.

Demolition or renovation activities may result in spreading of contamination resulting from removal of associated debris. To evaluate this possibility, samples at the extent soil disturbed by debris removal, inside the footprint of the former structure, and/or at depth are incorporated into the sampling strategies, as appropriate. The following sections detail sampling strategies for each condition.

4.1.2.1 *Foundation Present*

If the structure foundation or slab is present and the site has not been graded, a visual inspection of the site may be useful to help focus soil sampling around the structure foundation to sample areas with the highest potential for lead deposits.

The recommended number of sampling locations may vary depending on the type and number of structures, and conditions found. Table 2 provides a recommended minimum number of sampling locations for post-demolition sampling when the structure foundation is present. In general, more samples are recommended as the surface area of the structure increases.

Two sets of sampling locations should be distributed around the perimeter, one set within two feet of the structure foundation and the second corresponding set at the extent of soil disturbed by debris removal. Each of the sampling locations in the second set should be placed in line with one location in the first set. If concrete or asphalt borders the structure foundation, sampling locations should be placed in the nearest unpaved areas where associated runoff may collect. If soil is exposed within the footprint of the former structure, interior sampling locations should be distributed inside the footprint. Additional sampling locations may be used to evaluate potential release of lead beneath adjacent concrete or asphalt placed after the structure was constructed. Discrete surface (zero to six inches below ground surface) soil samples should be collected from each sampling location. A decision tree is provided in Figure 4 for placement of sampling locations and sample collection depths.

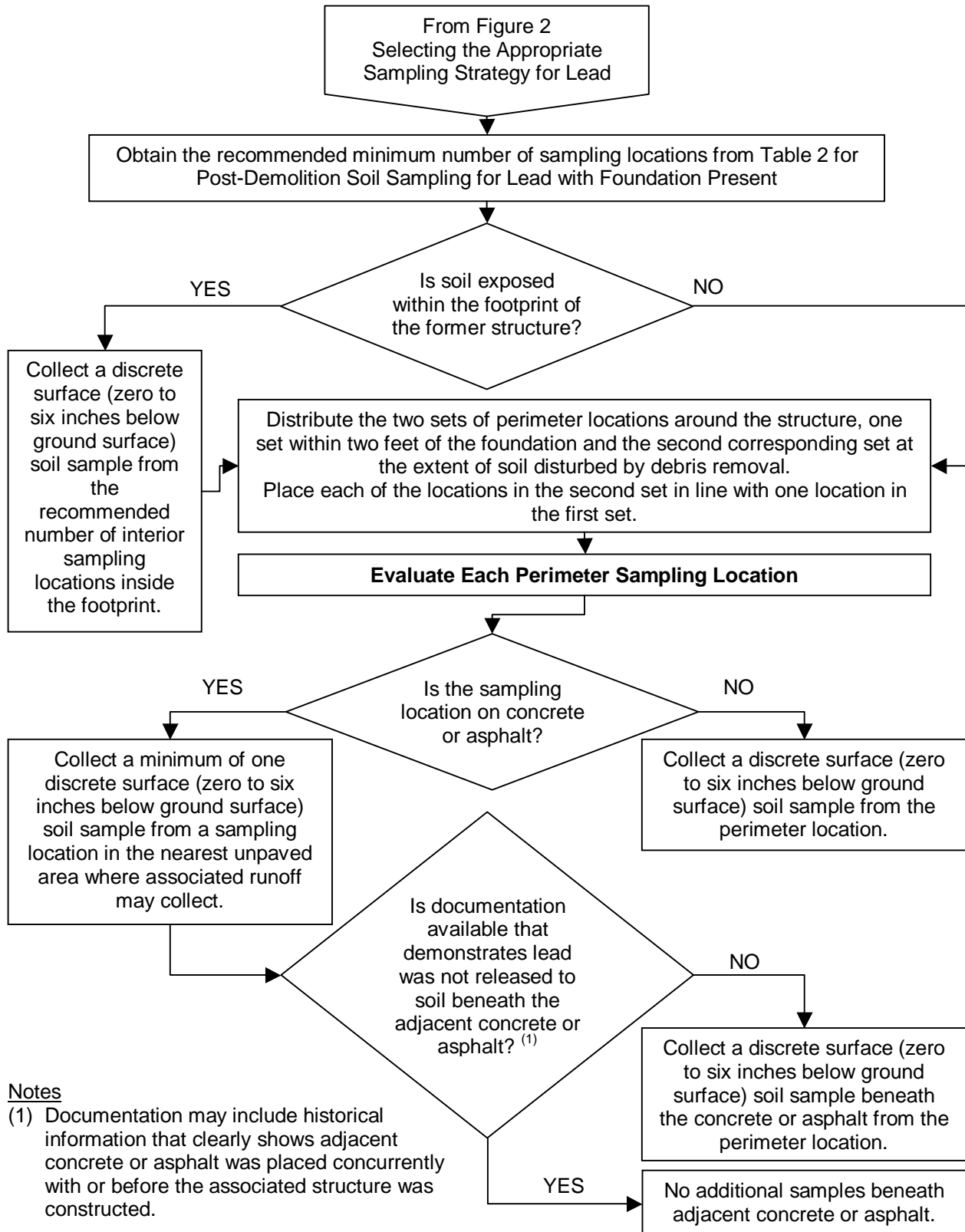
TABLE 2
Post-Demolition Soil Sampling for Lead
with Foundation Present
Recommended Minimum Number of Sampling Locations

Structure Type	Recommended Minimum Number of Sampling Locations ⁽¹⁾
Single-family housing, multi-family housing (up to and including four units), or detached carports/garages	<p>For each structure, two sets of four perimeter locations:</p> <ul style="list-style-type: none"> • First set within two feet of the structure foundation. • Second set at the extent of soil disturbed by debris removal⁽²⁾. <p>If soil is exposed within the footprint of the former structure, two interior locations distributed inside the footprint.</p>
Out buildings (shed or similar small structures)	<p>For each structure, two sets of two perimeter locations:</p> <ul style="list-style-type: none"> • First set within two feet of the structure foundation. • Second set at the extent of soil disturbed by debris removal⁽²⁾. <p>If soil is exposed within the footprint of the former structure, one interior location inside the footprint.</p>
Multi-family housing (more than four units), commercial structures, or barns	<p>For each structure, two sets of six perimeter locations:</p> <ul style="list-style-type: none"> • First set within two feet of the structure foundation. • Second set at the extent of soil disturbed by debris removal⁽²⁾. <p>If soil is exposed within the footprint of the former structure, four interior locations distributed inside the footprint.</p>

Notes

- (1) Additional sampling locations may be used to evaluate potential release of lead beneath adjacent concrete or asphalt placed after the structure was constructed. Refer to Figure 4 – Post-Demolition Sampling for Lead with Foundation Present, Placing Sampling Locations and Determining Collection Depths.
- (2) Place each sampling location in the second set in line with one location in the first set.

FIGURE 4
Post-Demolition Sampling for Lead with Foundation Present
Placing Sampling Locations and Determining Collection Depths



4.1.2.2 *Foundation Removed or Site Graded*

If the structure foundation or slab was removed or the surrounding soil was graded, the following procedure should be used to collect samples from the site:

1. Determine the number of recommended sampling locations for each structure historically or currently present on site based on type (See Table 3).
2. Add up the number of recommended sampling locations for each structure to obtain the total number of sampling locations for the site.
1. Overlay a grid onto the site. The number of grid cells should correspond to the total number of sampling locations for the site. Place one sampling location at the center of each grid cell. For sites with distinct use areas, such as agriculture with a residential structure, the grid should be placed over the area associated with the structure(s) and soil disturbed by demolition activities based on review of historical information.
2. Collect discrete surface (zero to six inches below ground surface) and subsurface (two to three feet below ground surface) soil samples from each sampling location.

The recommended number of sampling locations may vary depending on the type and number of structures, and conditions found. Table 3 provides recommended sampling locations and depths for post-demolition sampling when the structure foundation has been removed. In general, more samples are recommended as the surface area of the structure increases.

TABLE 3
Post-Demolition Soil Sampling for Lead
with Foundation Removed or Site Graded
Recommended Sampling Locations and Depths

Step 1: Determine the recommended number of sampling locations for each historic or current structure on site.	
Structure Type	Recommended Number of Sampling Locations
Single-family housing, multi-family housing (up to and including four units), or detached carports/garages	Six locations for each structure.
Out buildings (shed or similar small structures)	Four locations for each structure.
Multi-family housing (more than four units), commercial structure, or barns	Eight locations for each structure.
Step 2: Add up the number of sampling locations for each structure to obtain the total number of sampling locations for the site.	
Step 3: Overlay a grid onto the site. The number of grid cells should correspond to the total number of sampling locations for the site. Place one sampling location at the center of each grid cell. For sites with distinct use areas, such as agriculture with a residential structure, the grid should be placed over the area associated with the structure(s) based on review of historical information.	
Step 4: Collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ samples from each sampling location.	

Notes

- (1) Surface samples should be collected from zero to six inches below ground surface.
(2) Subsurface samples should be collected from two to three feet below ground surface.

4.2 Sample Analysis

Samples for lead in soil may be analyzed using field and/or laboratory methods. For analysis, subsamples of surface samples (zero to six inches below ground surface) should consist of the uppermost soil from the core (closest to ground surface). To assist the laboratory, the surface, or top of core, should be labeled in the field. Suggested analytical methods and quantitation limits for lead in soil are provided below.

It is advisable for soil samples to be analyzed pursuant to California Code of Regulations, title 22, section 69103, subsection (a)(2), which references United States Environmental Protection Agency (U.S. EPA) test methods available in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846 Third Edition, November 1986 (SW-846), as amended.

Preparation and analytical methods used should result in reporting the total lead concentration in the sample being analyzed. Quantitation limits for lead should be less than the reference concentration (e.g. screening value) used for comparison. Suggested quantitation limits are based on consideration of the applicable reference concentration and represent the level routinely achievable by the DTSC Environmental

Chemistry Laboratory. Suggested methods and quantitation limits for lead analysis are listed in Table 4.

TABLE 4
Methods and Quantitation Limits for Lead Analysis

Analyte	CASRN	Media	Analytical Method	Quantitation Limit (mg/kg or ppm)
Lead	7439-92-1	Soil	LABORATORY U.S. EPA Method 6010, 6020, or 7000 (AA only, not GFAA)	50
			FIELD U.S. EPA Method 6200 ⁽¹⁾	50

Abbreviations

AA	atomic absorption
CASRN	chemical abstracts registry number
GFAA	graphite furnace atomic absorption
mg/kg	milligrams per kilogram
ppm	parts per million
U.S. EPA	United States Environmental Protection Agency

Notes

- (1) On-site field analyses for lead in soil may be conducted using portable x-ray fluorescence (XRF) in accordance with U.S. EPA Method 6200 and supplemental guidelines described in Section 4.2.

On-site field analyses for lead in soil may be conducted using portable x-ray fluorescence (XRF) in accordance with U.S. EPA Method 6200 and the following supplemental guidelines.

- In-situ XRF analyses (i.e. readings taken directly off the soil) of lead in soil are not acceptable for this initial assessment.
- Training and Licensing
 - XRF operators should possess a Radioactive Materials License issued by the California Department of Health Services.
 - XRF operators should be trained to operate the specific piece of equipment used.
- Sample Preparation
 - As long as the samples are well homogenized, use of a No. 60 (250 µm) as described in U.S. EPA Method 6200 (U.S. EPA 1998a and 1998b), Section 11.6, sieve is optional. A No. 10 (2.0 mm) sieve may be used to remove large debris and obtain a total soil sample that includes both coarse and fine fractions (rather than just the fine fraction that passes through a No. 60 (250 µm) sieve).
 - Consistent with U.S. EPA Method 6200 (U.S. EPA 1998a and 1998b), Sections 7.2.2 and 11.5, microwave drying is not recommended; however, other methods and times may be used to dry the sample. Moisture content above 20 percent may interfere with analysis, since moisture

alters the soil matrix for which the field-portable XRF has been calibrated. The effect of moisture on XRF results is site-specific. Accordingly, samples should be sufficiently dried to obtain an acceptable correlation coefficient as described in the bulleted item for confirmatory samples below.

- Grinding of the sample as described in U.S. EPA Method 6200 (U.S. EPA 1998a and 1998b), Section 11.6, is optional and may not be necessary as long as the sample is sieved properly.
- Instrument Calibration
 - Initial and continuing calibration should be conducted in accordance with manufacturer's instructions for soil samples and a standard soil sample containing lead concentration near the screening value of 255 milligrams of lead per kilogram of soil (mg/kg) should be measured and documented. The development and use of the screening value for lead is presented in Section 4.3.
- Confirmatory Samples
 - A confirmatory sample should be a split sample from the well homogenized sample material. Confirmatory samples for 10 percent of the samples (but not less than five) should be forwarded for laboratory analysis. Consistent with U.S. EPA Method 6200 (U.S. EPA 1998a and 1998b), confirmatory samples should be selected from the lower, middle, and upper range measured using XRF. Samples with XRF results near the screening value of 255 mg/kg should also be included.
 - Consistent with U.S. EPA Method 6200, XRF results and laboratory analytical results for associated confirmatory samples should be evaluated with a least squares linear regression analysis (U.S. EPA 1998a and 1998b). The correlation coefficient (r^2) for the results should be 0.8 or greater for the XRF data to be used considered valid for this initial assessment of the site (U.S. EPA 1995a).

4.3 Data Interpretation and Assessment

After verifying and validating the analytical data as specified in Section 7.0, detected concentrations of lead in soil from lead-based paint should be compared to the screening value to determine if further investigation is required. The screening value for lead in soil from lead-based paint at proposed school sites is 255 milligrams per kilogram (mg/kg or parts per million, ppm). The value is derived using the DTSC Lead Risk Assessment Spreadsheet, LeadSpread 7 (DTSC 1999), and represents the soil concentration that is predicted to result in a 99th percentile estimate of blood lead equal to 10 micrograms of lead per deciliter of blood (µg/dL) for a child. The threshold blood lead value of 10 µg/dL is the level of concern identified by the United States Department of Health and Human Services, Centers for Disease Control and Prevention (CDC). The value is subject to change and revision when the DTSC Lead Risk Assessment Spreadsheet is updated or other information is made available.

The following input values were used in the worksheet to obtain the screening value:

- Lead in air: Default value of 0.028 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) based on ambient air lead concentration data from the California Air Resources Board.
- Lead in water: Default value of 15 micrograms per liter ($\mu\text{g}/\text{L}$) based on the California Maximum Contaminant Level.
- Home-grown produce: Zero percent since this pathway is not considered a potential exposure pathway for school sites.
- Respirable dust: Default value of $1.5 \mu\text{g}/\text{m}^3$ based on Table 3 in Appendix D of the U.S. EPA *Soil Screening Guidance: Technical Background Document* (U.S. EPA 1996b).

The maximum concentration of lead detected on the proposed school site should be compared to the screening value. Generally, sites with lead concentrations detected below the screening value will require no further action and those with lead concentrations detected at or above the screening value will require additional evaluation, investigation, or response action. However, these are general guidelines and DTSC will make a determination, such as additional evaluation for sites with lead concentrations approaching the screening value, based on site-specific information.

5.0 ORGANOCHLORINE PESTICIDES FROM TERMITICIDE APPLICATION

Organochlorine pesticides (OCPs) were commonly used as insecticides for termite control around structures. These OCPs included chlordane, lindane, heptachlor and aldrin, which readily converts to dieldrin in the environment.

OCPs were applied surficially to soil surrounding foundations and injected into the soil in an effort to isolate wood structures from termite nests (Ebeling 1975). Additionally, more recent federal requirements suggest that termite activity is generally limited to the upper four feet of soil (U.S. EPA 1996a). Historically, the following methods were used to apply OCPs for termite control:

- Pre-construction: Soil drenched with termiticides prior to construction of concrete slab foundations.
- Trenching: Trenches, approximately 12 inches deep, excavated around a structure near the foundation and filled with termiticide to saturate the soil to approximately 12 inches beneath the trench bottom.
- Spot treatment: Termiticide pumped into holes drilled into concrete foundations and surrounding soil in infested areas.
- Bait: Termiticide in food pellets placed underground.
- Homeowner: Termiticides applied surficially in and around structures.

Chlordane was used in the United States from 1948 until 1988, when it was banned by U.S. EPA. Because of evidence of human exposure and accumulation in body fat, as well as persistence in the environment and effects on wildlife, U.S. EPA prohibited the use of chlordane in 1988 to control termites around homes and structures. It is estimated that chlordane was applied to over 30 million homes in the United States,

often at concentrations far higher than those recommended by the manufacturer because of homeowner application (Kilburn and Thornton 1995). Chlordane is listed as one of the twelve persistent organic pollutants by U.S. EPA based on its resistance to chemical and biological degradation. When applied to soil around structures, chlordane adsorbs to organic matter and clay particles and slowly volatilizes into the atmosphere. The other OCPs which were also used as termiticides have also been banned by the U.S. EPA.

Chlordane is considered a Class B2 carcinogen by U.S. EPA (U.S. EPA 1997, 2002a), and is listed as a carcinogen by the State of California (OEHHA 2005). Chronic exposure of people to chlordane may also result in adverse effects on the nervous, respiratory, and cardiovascular systems, as well as the liver, blood, and lung. The other OCPs used as termiticides are also considered by both U.S. EPA and the State of California to be possible carcinogens.

Widespread application of chlordane and other OCPs is known to have occurred around structures in various regions (Colorado, Florida, Louisiana, Massachusetts, New Jersey, and Texas) throughout the United States. However, due to the lack of data on pesticide residues at residential properties in California and the prevalence of termites throughout the state (Ebeling 1975 and UC 2001), DTSC conducted an investigation of three proposed school sites with residential structures to evaluate the presence and prevalence of chlordane and other OCPs as a result of termiticide application. The results of this study are presented in the report, *Residential Pesticide Study, Final Report* (DTSC 2004).

The study focused on three proposed school sites with multiple housing units on each site in three Southern California counties (Los Angeles, San Bernardino, and San Diego). Risk-screening evaluation results indicated an unacceptable excess cancer risk for a residential, unrestricted land use scenario at all three sites, primarily associated with chlordane and dieldrin in surface soil. Approximately 50 percent of chlordane and dieldrin detections had an associated risk greater than one in a million ($>1 \times 10^{-6}$), and approximately 20 percent of chlordane and dieldrin detections had an associated risk greater than one in 100,000 ($>1 \times 10^{-5}$).

In addition to the three school sites included in the study, DTSC investigated OCPs from termiticide application at residential properties proposed for school sites in various counties throughout California, including Alameda, Contra Costa, Fresno, Kern, Los Angeles, Merced, Riverside, San Diego, San Joaquin, Santa Cruz, and Stanislaus. Of a total of 23 sites (including three sites from the study), further investigation and/or removal actions were conducted for OCPs from termiticide application at approximately 70 percent of the sites evaluated (DTSC 2004).

The results of this study indicate that it is likely that significant concentrations of OCP residues may exist around structures with wood components built prior to 1989 and should be evaluated at school sites.

5.1 Soil Sampling

A decision tree to determine whether OCPs in soil from termiticide application may be a concern and the appropriate strategy is provided in Figure 5 and details for pre- and post-demolition sampling strategies are provided in the following sections. The pre-demolition sampling strategy may also be followed to evaluate existing wooden structures, constructed prior to 1989, that will remain on site and be incorporated into the school.

Locations and depths of soil samples to be collected for OCPs may coincide with those to be collected for lead. If this occurs, the same soil samples analyzed for lead may be analyzed for OCPs.

5.1.1 PRE-DEMOLITION SAMPLING

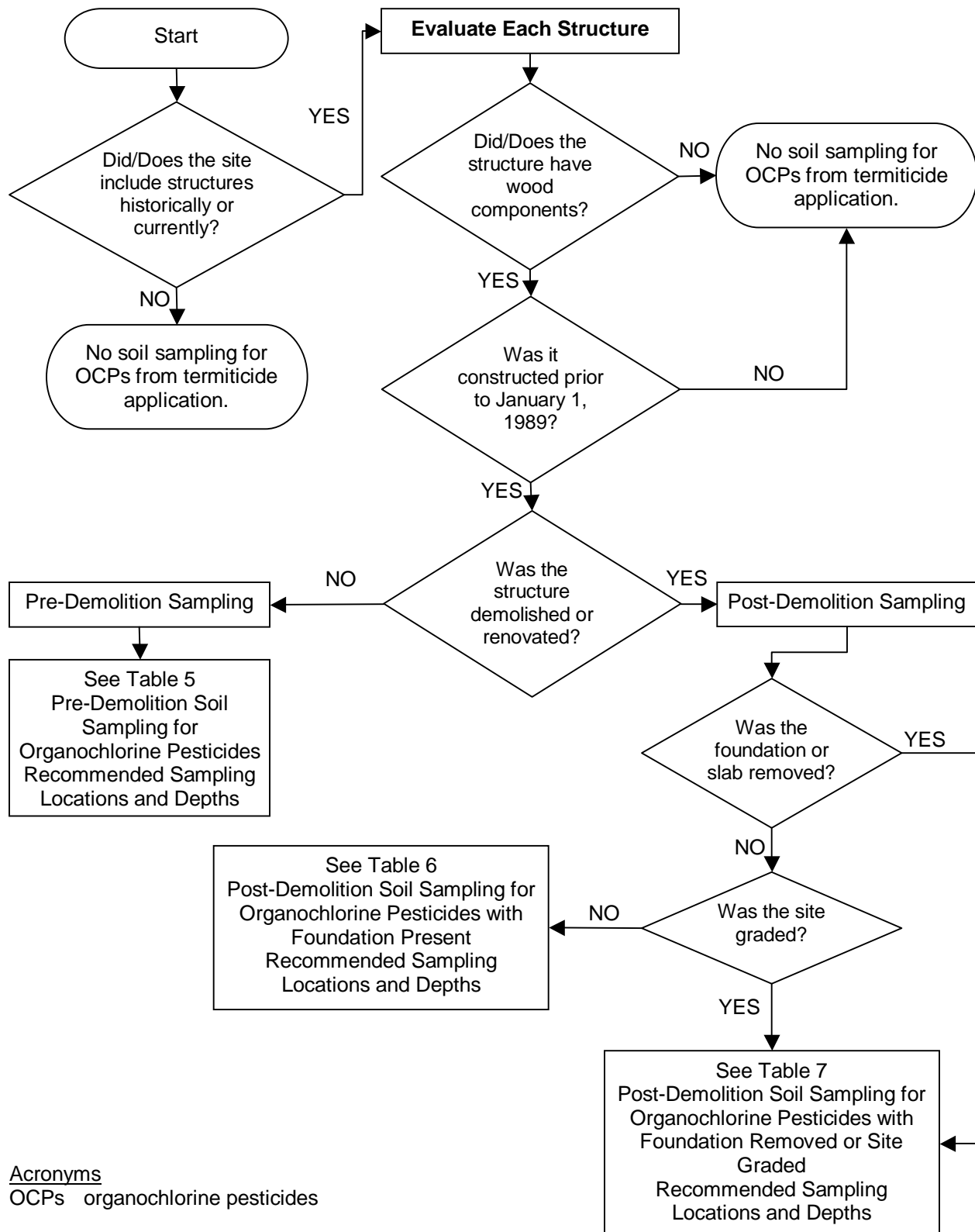
Soil sampling should be focused in areas with the highest potential for OCPs from termiticide application. The recommended number of sampling locations may vary depending on the type and number of structures, and conditions found. Table 5 provides recommended sampling locations, depths, and compositing guidelines for pre-demolition sampling. In general, more samples are recommended as the surface area of the structure increases.

Sampling locations should be distributed around the perimeter within two feet of the structure. Discrete surface (zero to six inches below ground surface) and subsurface (two to three feet below ground surface) soil samples should be collected from these perimeter locations. If concrete or asphalt borders the structure, samples should be collected beneath these paved areas. Termiticide was generally applied immediately adjacent to foundations, and in some cases, may have been injected around the foundation. DTSC is available to discuss collection of samples beneath existing paved areas if the integrity of a structure will be affected.

Additional sampling locations should be placed beneath a raised floors and/or porches, if present. Only discrete surface (zero to six inches below ground surface) soil samples should be collected from these interior locations:

The same type of sample (perimeter or interior) collected from a single structure at the same depth may be composited and analyzed instead of analyzing each discrete sample separately. A maximum of four discrete samples may be composited and analyzed. Guidelines for compositing samples are provided in Section 5.2.

FIGURE 5
Determining If Organochlorine Pesticides in Soil are a Concern and Selecting the Appropriate Sampling Strategy



Acronyms

OCPs organochlorine pesticides

TABLE 5
Pre-Demolition Soil Sampling for Organochlorine Pesticides
Recommended Sampling Locations and Depths

Structure Type	Recommended Locations and Depths
Single-family housing, multi-family housing (up to and including four units), or detached carports/garages	<p>For each structure, collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ soil samples from four perimeter locations within two feet of the structure, near the foundation, and beneath paved areas, if present.</p> <ul style="list-style-type: none"> • Four discrete surface samples can be composited for analysis. • Four discrete subsurface samples can be composited for analysis. <p>For each structure, collect discrete surface ⁽¹⁾ soil samples from four interior locations placed beneath raised floors and/or porches, if present.</p> <ul style="list-style-type: none"> • Four discrete surface samples may be composited for analysis.
Out buildings (shed or similar small structures)	<p>For each structure, collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ soil samples from two perimeter locations within two feet of the structure, near the foundation, and beneath paved areas, if present.</p> <ul style="list-style-type: none"> • Both discrete surface samples can be composited for analysis. • Both discrete subsurface samples can be composited for analysis. <p>For each structure, collect discrete surface ⁽¹⁾ soil samples from two interior locations placed beneath raised floors and/or porches, if present.</p> <ul style="list-style-type: none"> • Both discrete surface samples may be composited for analysis.
Multi-family housing (more than four units), commercial structures, or barns	<p>For each structure, collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ soil samples from six perimeter locations within two feet of the structure, near the foundation, and beneath paved areas, if present.</p> <ul style="list-style-type: none"> • Three discrete surface samples can be composited for analysis. • Three discrete subsurface samples can be composited for analysis. <p>For each structure, collect discrete surface ⁽¹⁾ soil samples from six interior locations placed beneath raised floors and/or porches, if present.</p> <ul style="list-style-type: none"> • Three discrete surface samples may be composited for analysis.

Notes

- (1) Surface samples should be collected from zero to six inches below ground surface.
(2) Subsurface samples should be collected from two to three feet below ground surface.

5.1.2 POST-DEMOLITION SAMPLING

Two post-demolition (structure has been demolished or renovated) sampling strategies are provided for conditions that may be encountered on a site:

- Foundation Present (Section 4.1.2.1)
 - Foundation present and site not graded.
- Foundation Removed or Site Graded (Section 4.1.2.2)
 - Foundation present and site graded.
 - Foundation removed and site not graded.
 - Foundation removed and site graded.

Demolition or renovation activities may result in spreading of contamination resulting from removal of associated debris. To evaluate this possibility, samples at the extent soil disturbed by debris removal are incorporated into the sampling strategies, as appropriate. The following sections detail sampling strategies for each condition.

5.1.2.1 *Foundation Present*

Soil sampling should be focused in areas with the highest potential for OCPs from termiticide application. The recommended number of sampling locations may vary depending on the type and number of structures, and conditions found. Table 6 provides recommended sampling locations, depths, and compositing guidelines for post-demolition sampling when the structure foundation is present. In general, more samples are recommended as the surface area of the structure increases.

Two sets of sampling locations should be distributed around the perimeter, one set within two feet of the structure foundation and the second corresponding set at the extent of soil disturbed by debris removal. Each of the sampling locations in the second set should be placed in line with one location in the first set. If soil is exposed within the footprint of the former structure, interior sampling locations should be distributed inside the footprint. Discrete surface (zero to six inches below ground surface) and subsurface (two to three feet below ground surface) soil samples should be collected from these perimeter and interior locations. If concrete or asphalt borders the structure, samples should be collected beneath these paved areas. Termiticide was generally applied immediately adjacent to foundations, and in some cases, may have been injected around the foundation. DTSC is available to discuss collection of samples beneath existing paved areas if the integrity of a structure will be affected.

The same type of sample (first set of perimeter, second set of perimeter, or interior) collected from a single structure at the same depth may be composited and analyzed instead of analyzing each discrete sample separately. A maximum of four discrete samples may be composited for analysis. Guidelines for compositing samples are provided in Section 5.2.

TABLE 6
Post-Demolition Soil Sampling for Organochlorine Pesticides
with Foundation Present
Recommended Sampling Locations and Depths

Structure Type	Recommended Sampling Locations and Depths
Single-family housing, multi-family housing (up to and including four units), or detached carports/garages	<p>For each structure, collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ soil samples from the following locations:</p> <ul style="list-style-type: none"> • First set of four perimeter locations within two feet of the structure foundation. <ul style="list-style-type: none"> - Four discrete surface samples may be composited for analysis. - Four discrete subsurface samples may be composited for analysis. • Second set of four perimeter locations at the extent of soil disturbed by debris removal ⁽³⁾. <ul style="list-style-type: none"> - Four discrete surface samples may be composited for analysis. - Four discrete subsurface samples may be composited for analysis. • If soil is exposed within the footprint of the former structure, two interior locations distributed inside the footprint. <ul style="list-style-type: none"> - Two discrete surface samples may be composited for analysis. - Two discrete subsurface samples may be composited for analysis.
Out buildings (shed or similar small structures)	<p>For each structure, collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ soil samples from the following locations:</p> <ul style="list-style-type: none"> • First set of two perimeter locations within two feet of the structure foundation. <ul style="list-style-type: none"> - Both discrete surface samples may be composited for analysis. - Both discrete subsurface samples may be composited for analysis. • Second set of two perimeter locations at the extent of soil disturbed by debris removal ⁽³⁾. <ul style="list-style-type: none"> - Both discrete surface samples may be composited for analysis. - Both discrete subsurface samples may be composited for analysis. • If soil is exposed within the footprint of the former structure, one interior location should be placed inside the footprint.
Multi-family housing (more than four units), commercial structures, or barns	<p>For each structure, collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ soil samples from the following locations:</p> <ul style="list-style-type: none"> • First set of six perimeter locations within two feet of the structure foundation. <ul style="list-style-type: none"> - Three discrete surface samples may be composited for analysis. - Three discrete subsurface samples may be composited for analysis. • Second set of six perimeter locations at the extent of soil disturbed by debris removal ⁽³⁾. <ul style="list-style-type: none"> - Three discrete surface samples may be composited for analysis. - Three discrete subsurface samples may be composited for analysis. • If soil is exposed within the footprint of the former structure, four interior locations distributed inside the footprint. <ul style="list-style-type: none"> - Four discrete surface samples may be composited for analysis. - Four discrete subsurface samples may be composited for analysis.

Notes

- (1) Surface samples should be collected from zero to six inches below ground surface.
(2) Subsurface samples should be collected from two to three feet below ground surface.
(3) Place each sampling location in the second set in line with one location in the first set.

5.1.2.2 *Foundation Removed or Site Graded*

If the structure foundation or slab was removed or the surrounding soil was graded, the following procedure should be used to collect samples from the site:

1. Determine the number of recommended sampling locations for each structure historically or currently present on site based on type (See Table 7).
2. Add up the number of recommended sampling locations for each structure to obtain the total number of sampling locations for the site.
3. Overlay a grid onto the site. The number of grid cells should correspond to the total number of sampling locations for the site. Place one sampling location at the center of each grid cell. For sites with distinct use areas, such as agriculture with a residential structure, the grid should be placed over the area associated with the structure(s) and soil disturbed by demolition activities based on review of historical information.
4. Collect discrete surface (zero to six inches below ground surface) and subsurface (two to three feet below ground surface) soil samples from each location.
5. As an option, up to four adjacent discrete samples from the same depth can be composited and analyzed.

Adjacent samples collected from the same depth may be composited and analyzed instead of analyzing each discrete sample separately. A maximum of four discrete samples may be composited for analysis. Guidelines for compositing samples are provided in Section 5.2.

The recommended number of sampling locations may vary depending on the type and number of structures, and conditions found. Table 7 provides recommended sampling locations and depths for post-demolition sampling when the structure foundation has been removed. In general, more samples are recommended as the surface area of the structure increases.

TABLE 7
Post-Demolition Soil Sampling for Organochlorine Pesticides
with Foundation Removed or Site Graded
Recommended Sampling Locations and Depths

Step 1: Determine the recommended number of sampling locations for each historic or current structure on site.	
Structure Type	Recommended Number of Sampling Locations
Single-family housing, multi-family housing (up to and including four units), or detached carports/garages	Six locations for each structure.
Out buildings (shed or similar small structures)	Four locations for each structure.
Multi-family housing (more than four units), commercial structures, or barns	Eight locations for each structure.
Step 2: Add up the number of sampling locations for each structure to obtain the total number of sampling locations for the site.	
Step 3: Overlay a grid onto the site. The number of grid cells should correspond to the total number of sampling locations for the site. Place one sampling location at the center of each grid cell. For sites with distinct use areas, such as agriculture with a residential structure, the grid should be placed over the area associated with the structure(s) based on review of historical information.	
Step 4: Collect discrete surface ⁽¹⁾ and subsurface ⁽²⁾ samples from each sampling location.	
Step 5: (Optional) Up to four adjacent discrete samples from the same depth can be composited for analysis.	

Notes

- (1) Surface samples should be collected from zero to six inches below ground surface.
(2) Subsurface samples should be collected from two three feet below ground surface.

5.2 Sample Compositing

A maximum of four discrete samples may be composited for analysis of OCPs around structures for the initial assessment in order to expedite the process and reduce associated analytical costs. However, compositing may increase labor and equipment costs due the additional time and equipment needed to prepare the composited samples. The following compositing guidelines are provided for each sampling strategy:

- Pre-demolition sampling – Discrete samples of the same type (perimeter or interior), collected from the same structure, at the same depth may be composited.
- Post-demolition sampling when the structure foundation is present – Discrete samples of the same type (first set of perimeter, second set of perimeter, or interior), collected from the same structure, at the same depth may be composited.

- Post-demolition sampling when the structure foundation is not present or site is graded – Discrete samples from adjacent locations, collected from the same depth, may be composited.

For compositing, discrete samples should be individually collected, homogenized, and split. A portion of the homogenized discrete sample should be preserved and archived in case additional analysis is necessary based on analytical results of the composited samples. Aliquots of equal amounts of soil from each homogenized discrete sample should be placed into a clean container, such as a bowl or plastic bag, and thoroughly homogenized. The resulting composited sample can be submitted for analysis.

To ensure the integrity of the samples and usability of the resulting data, it is recommended that sample handling and preservation follow SW-846 and subsequent amendments. Samples should be analyzed within the specified holding time. Soil samples collected in 250 milliliter (mL) wide-mouth glass containers with polytetrafluoroethylene (PTFE)-lined lids may be cooled to 4 Celsius (°C). Samples should be extracted within 14 days of collection, and extracts should be analyzed within 40 days following extraction (U.S. EPA 2000).

Adjustments to the screening values have been made to accommodate composited samples and are discussed in Section 5.4. The individual discrete samples should be analyzed when the results of a composited sample meets or exceeds the screening value.

5.3 Sample Analysis

It is advisable for soil samples to be analyzed using U.S. EPA test methods available in SW-846 (U.S. EPA 1986) and subsequent amendments, such as U.S. EPA Method 8081 or an equivalent method capable of attaining the quantitation limits listed in Table 8.

Quantitation limits for OCPs should be less than the reference concentration (e.g. screening value) use for comparison. Recommended quantitation limits for laboratory analysis of OCPs are listed in Table 8. These represent the lowest quantitation limits that can be routinely achieved by the DTSC Environmental Chemistry Laboratory.

TABLE 8
Quantitation Limits for Organochlorine Pesticides Analysis

Analyte	CASRN	Quantitation Limit (µg/kg or ppb)
Aldrin	309-00-2	5
gamma-BHC (Lindane)	58-89-9	5
alpha-Chlordane	5103-71-9	5
gamma-Chlordane	5103-74-2	5
Chlordane (not otherwise specified)	57-74-9	50
4,4'-DDD	72-54-8	5
4,4'-DDE	72-55-9	5
4,4'-DDT	50-29-3	5
Dieldrin	60-57-1	5
Heptachlor	76-44-8	5

Abbreviations and Acronyms

BHC	hexachlorocyclohexane, HCH
CASRN	chemical abstracts registry number
4,4'-DDD	p,p'-Dichlorodiphenyldichloroethane
4,4'-DDE	p,p'-Dichlorodiphenyldichloroethylene
4,4'-DDT	p,p'-Dichlorodiphenyltrichloroethane
µg/kg	micrograms per kilogram
ppb	parts per billion
U.S. EPA	United States Environmental Protection Agency

5.4 Data Interpretation and Assessment

After verifying and validating the analytical data as specified in Section 7.0, the detected concentrations of OCPs from termiticide application in soil should be compared to respective screening values to determine if further investigation is required. The screening values for OCPs are from the California Human Health Screening Levels (CHHSLs; Cal/EPA 2005) for soil for residential land use. CHHSLs are risk-based screening concentrations developed by the California Environmental Protection Agency (Cal/EPA) and are subject to change and revision as updated toxicological information is made available. An abbreviated list of CHHSLs for the most common OCPs used to control termites is provided in Table 9. Adjustments (screening value divided by the number of discrete samples in a composited sample) to the screening values for composited samples are also included in Table 9 (U.S. EPA 1995b).

The maximum concentration of each OCP detected on the proposed school site should be compared to the respective screening value. Generally, sites with OCP concentrations detected below the screening value will require no further action and those with OCP concentrations at or above the respective screening value will require additional evaluation, investigation, or a response action. However, these are general guidelines and DTSC will make a determination based on site-specific information, such

as additional evaluation for sites with concentrations of OCPs approaching the screening value.

TABLE 9
Soil Screening Values for Organochlorine Pesticides
for Discrete and Composited Samples

Analyte	Discrete Sample Screening Value (µg/kg or ppb) ⁽¹⁾	Composited Sample Screening Value (µg/kg or ppb)		
		1:2	1:3	1:4
	Composite Ratio (Composite:Discrete)			
Aldrin	33	16	10	5
gamma-BHC (Lindane)	500	250	160	125
Chlordane (all forms)	430	215	140	105
4,4'-DDD	2,300	1,150	760	575
4,4'-DDE	1,600	800	530	400
4,4'-DDT	1,600	800	530	400
Dieldrin	35	16	10	5
Heptachlor	130	60	40	20

Abbreviations and Acronyms

BHC	hexachlorocyclohexane, HCH
CASRN	chemical abstracts registry number
4,4'-DDD	p,p'-Dichlorodiphenyldichloroethane
4,4'-DDE	p,p'-Dichlorodiphenyldichloroethylene
4,4'-DDT	p,p'-Dichlorodiphenyltrichloroethane
µg/kg	micrograms per kilogram
ppb	parts per billion

Notes

- (1) California Human Health Screening Levels for soil for residential land use (Cal/EPA 2005).
- (2) Screening values for composited samples are decreased in proportion to the number of discrete samples that makeup the composite sample in an effort to ensure hot spots are not missed (i.e. 100 percent of the measure concentration in a composited sample is from only one of the associated discrete samples).

6.0 POLYCHLORINATED BIPHENYLS FROM ELECTRICAL TRANSFORMERS

Polychlorinated biphenyls (PCBs) are man-made chemicals commonly used in the past as coolants and lubricants. PCBs are found as a clear to yellow, heavy oily liquid or waxy solid. PCBs were frequently used as insulation in electrical equipment because of their stability, low water solubility, high boiling point, low flammability, and low electrical conductivity (ATSDR 2001, DTSC 2003, and U.S. EPA 2004a). PCBs were produced in the United States from approximately 1929 to 1977. Production of PCBs was banned in the United States by the Toxic Substances Control Act (TSCA) in 1978 due to evidence of accumulation in the environment and link to harmful health effects (DTSC 2003). U.S. EPA considers PCBs to be probable human carcinogens (U.S. EPA 2004c) and they are listed as carcinogens by the State of California (OEHHA 2005). PCBs may have serious effects on the immune, reproductive, nervous, and endocrine systems (U.S. EPA 2004c).

Prior to 1978, PCBs were often used in the manufacture of transformers and capacitors, and leaks or releases from transformers producing contaminated areas have been documented. The age of the transformer does not necessarily indicate the presence or absence of impacts to soil from PCBs, as releases of PCBs from a previous transformer may have occurred before its replacement. Once released to the environment, PCBs bind to soil particles and are very persistent.

Soil sampling is not necessary for transformers installed for the first time on or after January 1, 1979. Soil sampling should be conducted for any historical (removed or replaced by a newer transformer) or current transformers installed before January 1, 1979.

6.1 Soil Sampling

Since PCBs in soil generally do not migrate significantly, soil sampling should be focused around the base of each pole- or pad-mounted electrical transformer. Surface (zero to six inches below ground surface) and subsurface (two to three feet below ground surface) soil samples should be collected in the area with the highest potential for a release from the transformer. If a historical pad-mounted transformer, installed before January 1, 1979, was replaced by a newer transformer, samples should be collected beneath the replacement pad to evaluate potential releases from the historical transformer. Table 10 provides recommended sampling locations and depths.

TABLE 10
Recommended Soil Sampling Locations and Depths for Polychlorinated Biphenyls

Transformer Type	Sampling Locations	Sample Depths
Pole-mounted	One location within close proximity of the base of the pole or in areas of visible staining.	For each sampling location: <ul style="list-style-type: none"> • One discrete surface ⁽¹⁾ soil sample. • One discrete subsurface ⁽²⁾ soil sample.
Pad-mounted	Two locations within close proximity of the transformer or in areas of visible staining.	For each sampling location: <ul style="list-style-type: none"> • One discrete surface ⁽¹⁾ soil sample. • One discrete subsurface ⁽²⁾ soil sample.

Notes

- (1) Surface samples should be collected from zero to six inches below ground surface.
(2) Subsurface samples should be collected from two to three feet below ground surface.

6.2 Sample Analysis

Initially surface samples may be analyzed for PCBs and subsurface samples may be preserved and archived. To ensure the integrity of the samples and usability of the resulting data, it is recommended that sample handling and preservation follow SW-846 and subsequent amendments. Samples collected in 250 mL wide-mouth glass containers with PTFE-lined lids may be cooled to 4°C with no specified holding time (U.S. EPA 2000). However, U.S. EPA Method 8082 recommends refrigerating extracts in the dark and analyzing with 40 days of extraction (U.S. EPA 2000). If PCBs are detected in surface samples, subsurface samples should be analyzed.

It is advisable for soil samples to be analyzed pursuant to California Code of Regulations, title 22, section 69103, subsection (a)(2), which references U.S. EPA test methods available in SW-846 (U.S. EPA 1986) and subsequent amendments, such as U.S. EPA Method 8082 or an equivalent method capable of attaining the quantitation limits listed in Table 11.

Quantitation limits for PCBs should be less than the reference concentration (e.g. screening value) use for comparison. Suggested methods and quantitation limits for laboratory analysis of PCBs are listed in Table 11. These represent the lowest quantitation limits that can be routinely achieved by the DTSC Environmental Chemistry Laboratory.

TABLE 11
Quantitation Limits for Polychlorinated Biphenyls Analysis

Analyte	CASRN	Quantitation Limit (mg/kg or ppm)
Aroclor-1016	12674-11-2	0.300
Aroclor-1221	11104-28-2	0.300
Aroclor-1232	11141-16-5	0.300
Aroclor-1248	12672-29-6	0.300
Aroclor-1254	11097-69-1	0.300
Aroclor-1260	11096-82-5	0.300

Abbreviations and Acronyms

CASRN	chemical abstracts registry number
mg/kg	milligrams per kilogram
ppm	parts per million
U.S. EPA	United States Environmental Protection Agency

6.3 Data Interpretation and Assessment

After verifying and validating the analytical data as specified in Section 7.0, the detected concentrations of PCBs (reported in concentrations of Aroclors) from electrical transformers in soil should be compared to the screening value to determine if further investigation is required. The soil screening value for PCBs from electrical transformers at proposed school sites is 0.300 mg/kg or ppm. This value corresponds to an approximate incremental cancer risk of 3.4×10^{-6} . Note that the CHHSL (Cal/EPA 2005) for PCBs in soil for residential land use is 0.089 mg/kg or ppm. However, this value cannot be routinely quantified through laboratory analysis.

The maximum concentration of each Aroclor detected on the proposed school site should be compared to the screening value. Unless sites have PCB concentrations detected above the screening value, no further action is required.

7.0 QUALITY ASSURANCE/QUALITY CONTROL

Site evaluation for lead, OCPs, and PCBs from specific sources described herein should include quality assurance/quality control (QA/QC) measures as part of sampling and analytical procedures. The purpose of these measures is to produce data of a known quality. The following QA/QC measures are recommended for cases in which limited number of samples are collected over a relatively short period of time.

- QA/QC samples
- Laboratory report
- Data validation memorandum

At a minimum, the QA/QC samples are listed in Table 12 should be used. These should be supplemented by additional laboratory QA/QC samples analyzed as part of standard laboratory practice.

TABLE 12
Quality Assurance/Quality Control Samples

Sample Type	Purpose	Preparation	Frequency
Field QA/QC Samples			
Collocated samples	Determine local variability of the soil and contamination at the site.	Collected within 0.5 to 3 feet of a field sample.	At least 10 percent of samples collected per event should be either collocated samples or field replicates. Minimum of one per matrix.
Field replicates (also known as field duplicates)	Assess error associated with sample heterogeneity, sample methodology and analytical procedures.	Split sample of a homogenized field sample.	
Equipment blanks (also known as rinsate blanks)	Assess cross-contamination resulting from improper decontamination procedures.	Run analyte-free water over decontaminated reusable sampling equipment to test for residual contamination.	One equipment blank per matrix per day, not to exceed one blank per 10 samples.
Field blanks	Evaluate contamination error associated with sampling methodology and laboratory procedures	Prepared in the field using clean sand or soil.	Minimum of one field blank sample per matrix per day if disposable sampling equipment is used and equipment blanks are not collected.
Temperature blank	Check the temperature of samples upon receipt at the laboratory.	40 milliliter VOA vial labeled, "temperature blank" in each cooler.	One per cooler.
Laboratory QA/QC Samples			
Matrix Spike (MS) and Matrix Spike Duplicate (MSD) Samples	Used to check sample matrix interferences.	Field samples spiked in the laboratory with a known concentration of a target analyte to verify percent recoveries.	Minimum of one MS/MSD pair per 14 days or one per 20 samples (including blanks and duplicates), whichever is greater.

(DTSC 1994, U.S. EPA 2004d and 1995a)

A laboratory report should include the following information:

1. Environmental laboratory identification and verification that the laboratory is certified under the State of California Environmental Laboratory Accreditation Program (ELAP) or the National Environmental Laboratory Accreditation Program (NELAP) in the appropriate field of testing.
2. Case narrative signed by the laboratory manager, director, or designee that includes the following information:
 - a. Client identification, project name, and site identification
 - b. Sample designation
 - c. Sample matrix

- d. Analytical method and analytes
 - e. Dates of sample collection, preservation, preparation, extraction, and analysis
 - f. Reporting units and quantitation limits
 - g. Dilution factors
 - h. Report page numbering system
 - i. Holding times met or exceeded
 - j. Description of problems
 - k. Discussion of QA/QC criteria outside of acceptance limits and adverse impacts to sample integrity or data quality
 - l. Discussion of sample handling.
3. Chain of custody forms
 4. Holding times
 5. Sample preservation
 6. Field samples
 7. Field QA/QC samples (e.g. collocated samples, field blanks, field replicates, rinsate blanks, as applicable)
 8. Laboratory QA/QC samples (e.g. method blanks, laboratory control samples, matrix spike and matrix spike duplicate samples)
 9. Surrogate spike recoveries (applicable for organic analyses only)
 10. Summary of environmental results
 11. Compound identification and quantification
 12. Observations regarding any occurrences which may adversely affect sample integrity or data quality
 13. Detailed description of all variances encountered during analysis, possible reasons, and corrective actions.

A data validation memorandum should be prepared by a qualified professional, such as a project manager, project QA/QC manager, or third-party QA/QC specialist. In addition to providing an evaluation of the information provided in the laboratory report, the memorandum should evaluate completeness of the laboratory report.

A data report for on-site field analysis for lead in soil using a portable XRF should include the following items:

1. XRF operator identification and verification that the operator has a Radioactive Materials License issued by the California Department of Health Services and training to operate the specific piece of equipment used.
2. Case narrative signed by the certified XRF operator performing the analyses that includes:
 - a. Client identification, project name, and site identification
 - b. Sample designation
 - c. Sample matrix
 - d. Analytical method and analytes
 - e. Dates of sample collection, preparation, and analysis
 - f. Reporting units and quantitation limits
 - g. Report page numbering system
 - h. Description of problems

- i. Discussion of deviations from the recommended method and supplemental guidelines provided herein
- j. Discussion of QA/QC criteria outside of acceptance limits and adverse impacts to sample integrity or data quality
- k. Discussion of sample preparation and handling.
- 3. Chain of custody forms or field log sheets indicating sample collection dates and times.
- 4. Initial and continuing calibration.
- 5. Field samples
- 6. Field QA/QC samples (e.g. colocated samples, field blanks, field replicates, rinsate blanks, as applicable)
- 7. Compound identification and quantification.
- 8. Associated raw data

A data validation memorandum should be prepared by a qualified professional, such as a project manager, project QA/QC manager, or third-party QA/QC specialist. In addition to providing an evaluation of the information provided in the XRF data report, the memorandum should evaluate completeness of the report and correlation with associated laboratory analysis of confirmatory samples, and should include the following:

- Presentation and evaluation of laboratory analytical results for confirmatory samples.
 - Consistent with U.S. EPA Method 6200, XRF results and laboratory analytical results for associated confirmatory samples should be evaluated with a least squares linear regression analysis (U.S. EPA 1998a and 1998b). The correlation coefficient (r^2) for the results should be 0.8 or greater for the XRF data to be used considered valid for this initial assessment of the site (U.S. EPA 1995a).
- Determination regarding the validity of XRF for the initial assessment of the site.

8.0 PRESENTATION OF DATA

Sampling results and supporting information should be presented in a document such as a Phase I, Phase I Addendum, PEA, or SSI. The information included in the document should:

- Identify the recognized environmental concerns (lead-based paint, termiticides, or electrical transformers) being addressed and the related source of information.
- If DTSC provided a previous determination for the site, provide the date of the determination letter and include a copy of the letter in the appendix.
- Describe the results of visual inspections used to focus soil sampling.
- Describe the sampling approach.
- Identify sampling locations, depths, designation, and rationale.
- Describe the sample collection methods.
 - Sampling methods: Identify the standard operation method and step-by-step procedures of how each sample was collected, including equipment field quality controls.

- Sample containers and preservation: Identify the types of containers and preservatives used for the different analyses and provide the pre-cleaning method used for the containers.
- Sample packaging and shipment: Describe the methods for packaging, labeling, marking and shipping the samples.
- Sample documentation: Describe the label and provide an example. Describe the unique number system used to positively identify each sample without distinguishing the QA/QC samples from other samples. Discuss the field documentation used and include field logs, photographs, and QC checklist or logs, and chain-of-custody forms in an appendix.
- Describe the sample preparation methods used to homogenize, split, and composite samples.
- Describe the QA/QC samples collected.
- List the analyses performed on each sample or group of samples, associated quantitation limits and holding times.
- Describe the field activities conducted in sufficient detail to demonstrate compliance with applicable requirements and to permit reconstruction by another environmental assessor.
 - Decontamination: Describe equipment decontamination procedures.
 - Field conditions: Include a qualitative summary of soil conditions with appropriate description of lithologic changes or evidence of fill material within a designated area. Discuss field variances from the guidance.
 - Health and Safety: Describe any health and safety procedures followed in the field, including safety equipment, personal protective equipment, level of protection, health and safety meetings, hazards encountered, and any instrument readings recorded. If XRF was used for lead analysis, include the qualifications of the operator, standard operating procedures, notes and compliance with radioactive safety requirements.
 - Waste management: Describe the management and disposition of wastes generated during the investigation, including soil cuttings, personal protective equipment, decontamination water, etc. Justification for the management and disposition of wastes should also be provided and should be consistent with the U.S. EPA Guide to Management of Investigation-Derived Wastes (IDW; U.S. EPA 1992).
- Discuss the analytical results.
- Evaluate the overall QA/QC used to ensure that sampling, field and laboratory chain-of custody, laboratory analyses, field and laboratory data measurements, and reporting activities provide data quality consistent with the intended use. As part of the project QA/QC evaluation, data validation should be performed for all submitted samples. Data quality should be defined by data quality indicators (accuracy, precision, method reporting limits, completeness, representativeness, and comparability). A summary of data validation should be included.
- Interpret the data and compare to screening values.
- Provide conclusions and recommendations based on comparison of sampling results to the provided health screening criteria.

- Include references to identify published referenced sources relied upon during the evaluation. Each referenced source shall be adequately annotated to facilitate retrieval by another party.
- Appendices should include site photographs, field logs, XRF data reports, analytical laboratory data reports, chain-of-custody documentation, and IDW disposal documentation, such as uniform hazardous waste manifests or bill of lading for non-hazardous waste.
- Figures
 - Site Vicinity Map – This map should include a north arrow, be to scale, and show the general location of the site relative to its surrounding area, including major highways, surface water bodies, land use, sensitive populations, and critical habitats.
 - Site Plan – This plan should include a north arrow, be to scale, and be of sufficient detail to show significant site features, including site boundaries, land use, paved areas, structures, drainage patterns, current uses of the site, areas of known or suspected environmental conditions.
 - Sampling Locations with Analytical Results – This figure should show the samples collected and the associated analytical results overlaid onto the Site Plan. The figure should clearly show the sampling locations relative to the areas of recognized environmental conditions. The sampling locations, depths, matrices, analytes, detected concentrations, quantitation limit for non-detect concentrations, and concentration units should be clearly presented.
- Tables
 - Summary of analytical results, including analytical method, sampling locations, depths, matrix, detected concentrations, quantitation limit for non-detect concentrations, units, and comparison to screening values.

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PREFACE

Under the Education Code, sections 17210, 17210.1, 172131, and 17213.2, school districts planning to utilize state bond funds for school property acquisition or construction are required to conduct environmental reviews for hazardous materials for kindergarten through grade 12 school facilities. Since January 2000, DTSC's role has been to provide oversight of environmental investigations at proposed new or expanding school sites to ensure protection of children, staff, community, and the environment from the potential effects of exposure to hazardous materials. In September 2004, the California Department of Toxic Substances Control (DTSC) completed a Residential Pesticide Study (Study) to evaluate the presence of chlordane and other organochlorine pesticides (OCPs) used as insecticides to control termites at three proposed school sites in California.. This report was peer reviewed by the Office of Environmental Health Hazard Assessment, California Environmental Protection Agency in March 2005..


Studies conducted between 1971 and 2004 in other regions of the United States (Massachusetts, New Jersey, Florida, Texas, Louisiana, Missouri, and Colorado) identified the persistence of chlordane in soils around houses 21 years or more after application.. Chlordane and other OCPs (e.g., heptachlor, aldrin, and dieldrin) were commonly used as pesticides on agricultural crops, lawns, and gardens, and as insecticides around structures throughout the U.S. from 1948 until 1988.. The most frequently used OCP was chlordane, which was applied to over 30 million homes in the U.S. , often at higher concentrations than recommended by the manufacturers. Above-ground use of chlordane was phased out between 1978 and 1983 by the United States Environmental Protection Agency (U.S. EPA), although chlordane was used as a termiticide for wooden structures until it was prohibited in 1988.. Chlordane is resistant to chemical and biological degradation, adsorbs to organic matter and clay particles in soils, and slowly volatilizes to the atmosphere. Human exposure may occur through subsurface vapor intrusion into homes.. Chlordane is considered to be a probable human carcinogen by U.S.. EPA (U. S. EPA 1997, 2002) and is listed as a carcinogen by the State of California (OEHHA 2005).. It may cause both chronic and acute health effects, and is of particular concern to children's health, impacting development of the immune; neuroendocrine, and reproductive organ systems..

For the DTSC Study in 2004, three proposed school sites, located in Los Angeles (Weemes Elementary School Expansion), San Diego (Cherokee Point Elementary School), and San Bernardino (Jones Elementary School)-were selected--to evaluate the presence of OCPs at residential properties in California.. The school sites were selected to study variations in location, acreage, and number of residential properties. The size of the proposed school sites ranged from 0.6 acres at Weemes to 7 acres at Cherokee and 11 acres at Jones; the number of residential properties ranged from four homes at Weemes to 38 homes at Cherokee and 51 lots with multiple unit dwellings at Jones.. There was no previous agricultural, industrial, or commercial use at any of the proposed school sites,

At the three proposed school sites, DTSC staff collected a total of 176 soil samples at three depths around building perimeters.. Samples were analyzed for OCPs by a California certified laboratory using U. S.. EPA method 8081A. OCPs were most frequently detected in the surface soil samples (0 to 0.5 feet below ground surface); the OCPs most frequently detected were chlordane (98 percent), DDT (95 percent), DDE (91 percent), and dieldrin (71 percent) A human health screening evaluation was conducted


for each property, using maximum detected concentrations to estimate potential carcinogenic risks and noncarcinogenic health hazards in conjunction with health-based toxicity criteria developed by U.S. EPA and California Office of Environmental Health Hazard Assessment (OEHHA). Risk-screening evaluation results indicated elevated risks and hazards to human health at all three sites, associated primarily with chlordane and dieldrin in surface soils. Approximately 50 percent of chlordane and dieldrin detections had an associated risk greater than 1 in a million ($> 1 \times 10^{-6}$), and approximately 20 percent of chlordane and dieldrin detections had an associated risk greater than 1 in 100,000 ($> 1 \times 10^{-5}$). The levels detected presented an unacceptable risk to children and adults under a residential, unrestricted land use scenario.

In addition to the three school sites included in the Study, DTSC has investigated OCPs at additional residential properties proposed for school sites in numerous California counties, including Alameda, Contra Costa, Fresno, Imperial, Los Angeles, Madera, Orange, Riverside, San Bernardino, San Diego, San Joaquin, San Mateo, Santa Cruz, Santa Barbara, Stanislaus, Tehama, Tulare, and Ventura (see attached listing). Based on results of the Study and investigation results at these additional proposed school sites, DTSC recommends sampling and analysis for OCPs be routinely conducted at proposed school sites historically used for residential properties. To facilitate the environmental review process for former residential properties, which might otherwise be expected to pose fewer environmental concerns than sites with other historic uses (e.g., agricultural, commercial or industrial), DTSC recommends that sampling for OCPs at proposed school sites be conducted in conjunction with the DTSC protocol for investigation of contamination from lead-based paint and polychlorinated biphenyls (PCBs) from transformers in Phase I Environmental Site Assessments, Preliminary Environmental Assessments, Supplemental Site Investigations, and/or Remedial Investigations.. •,



Stephen Dizio, Chief
Human and Ecological Risk Division
Department of Toxic Substances Control

5/8/06
Date



Hamid Saebfar, Chief
School Property Evaluation and Cleanup Division
Department of Toxic Substances Control

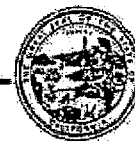
4/27/06
Date

OCP INVESTIGATIONS AT RESIDENTIAL PROPERTIES

	PROJECT NAME	CITY	COUNTY	COMMENTS
1	BURBANK E.S./HAYWARD JOINT USE PARK	Hayward	ALAMEDA	OCP's Identified
2	COMPREHENSIVE HIGH SCHOOL NO. 2	Bakersfield	KERN	OCP's Identified
4	ELEMENTARY SCHOOL SITE	Sanger	FRESNO	OCP's Identified
5	JEFFERSON ELEMENTARY SCHOOL	San Leandro	ALAMEDA	OCP's Identified
6	JOSEPH A. GREGORI HIGH SCHOOL SITE	Modesto	STANISLAUS	OCP's Identified
7	SAND CREEK ELEMENTARY SCHOOL	Brentwood	CONTRA COSTA	OCP's Identified
8	ELEMENTARY SCHOOL 2CD	Vacaville	SOLANO	OCP's Identified
9	WALNUT ELEMENTARY 2 ACRE ADDITION	Turlock	STANISLAUS	OCP's Identified
10	CHEROKEE POINT ELEMENTARY	San Diego	SAN DIEGO	OCP's Identified
11	MIDLAND ELEMENTARY SCHOOL	Poway	SAN DIEGO	OCP's Identified
12	NOBLE NEW ELEMENTARY SCHOOL NO. 1	Panorama City	LOS ANGELES	OCP's Identified
13	RICHARD PITTMAN ELEMENTARY SCHOOL	Stockton	SAN JOAQUIN	OCP's Identified
14	WEEMES ELEMENTARY SCHOOL PLAYGROUND	Los Angeles	LOS ANGELES	OCP's Identified
15	OAKDALE HIGH SCHOOL EXPANSION	Oakdale	STANISLAUS	OCP's Identified
16	SOQUEL AVENUE PROPERTY	Santa Cruz	SANTA CRUZ	OCP's Not Identified
17	STATE STREET ELEMENTARY SCHOOL	Huntington Park	LOS ANGELES	OCP's Identified
18	JOHN HAM HIGH SCHOOL	Lynwood	LOS ANGELES	OCP's Identified
19	LIVINGSTON HIGH SCHOOL EXPANSION	Livingston	MERCED	OCP's Identified
20	MADISON STREET ELEMENTARY NO. 227	Indio	RIVERSIDE	OCP's Identified
21	PATRICIA BEATTY ELEMENTARY SCHOOL	Riverside	RIVERSIDE	OCP's Identified
22	LAS JUNTAS ELEMENTARY SCHOOL	Martinez	CONTRA COSTA	OCP's Not Identified
23	JONES ELEMENTARY SCHOOL	San Bernardino	SAN BERNARDINO	OCP's Identified



Office of Environmental Health Hazard Assessment



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Alan C. Lloyd, Ph.D.
Agency Secretary

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Governor

MEMORANDUM

TO: Stephen Di Zio, Chief
Human and Ecological Risk Division
Department of Toxic Substances Control
8810 Cal Center Drive 2nd Floor
Sacramento, California 95826

FROM: Jim Carlisle, D.V.M., Chief
Applied Risk Assessment Unit
Integrated Risk Assessment Section

Via: David M. Siegel, Ph.D., Chief
Integrated Risk Assessment Section

DATE: March 21, 2005

SUBJECT: OEHHA COMMENTS ON THE SEPTEMBER 20, 2004 FINAL REPORT ON
THE RESIDENTIAL PESTICIDE STUDY

Overall, the study appears to have been well conducted and the results reported clearly and comprehensively. I am sending separately (by electronic mail) a copy of the Final Report on the Residential Pesticide Study with a few suggested edits in "track changes" mode. None of the suggested edits are of a critical nature, but they may help the document to read better, particularly to a lay audience.

If you have any questions please contact me at (916)-323-2635 thank you.

California Environmental Protection Agency

The energy challenge facing California is real. Every Californian needs to take immediate action to reduce energy consumption



Printed on Recycled Paper

Acknowledgements

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Arnold Schwarzenegger
Governor

Final Report Residential Pesticide Study

May 8, 2006

1. INTRODUCTION

Chlordane, an organochlorine pesticide, was used in the United States from 1948 until 1988, when it was banned by the U.S. EPA (U.S. EPA, 1990). Before 1978, chlordane was used as a pesticide on agricultural crops, lawns, and gardens and as a fumigating agent. Because of evidence of human exposure and accumulation in body fat as well as persistence in the environment and effects in wildlife, the EPA canceled the use of chlordane on food crops and phased out other above-ground uses from 1978 to 1983. From 1983 to 1988, the only approved use of chlordane was to control termites in homes, where it was poured or injected around foundations (McConnachie and Zahalsky, 1992). It was applied to over 30 million homes in the United States, and was often applied at concentrations far higher than those recommended by the manufacturer (Kilburn and Thornton, 1995).

Other organochlorine pesticides, including heptachlor and aldrin, which readily converts to dieldrin in the environment, were also commonly used as insecticides around structures (ATSDR, 2002). For this reason, while chlordane was initially the primary contaminant of concern, the full suite of organochlorine pesticides were included in chemical analysis of samples collected in this study using EPA Method 8081A.

1.1 Fate and Transport

Because of its resistance to chemical and biological degradation (WHO, 2003), chlordane is listed as one of 12 persistent organic pollutants by the EPA (Wania and Mackay, 1996; Fisher, 1999). Despite its persistence, chlordane has a low potential for groundwater contamination due to its low water solubility, but it does bind strongly to sediment particles in the water column. When applied to the soil around structures, chlordane adsorbs to organic matter and clay particles and slowly volatilizes into the atmosphere (ATSDR, 1995). The application of chlordane as a termiticide in residential areas was most prevalent in areas where termite infestations are common: from the lower New England states south and west to the lower portion of Colorado and up to Northern California (EPA, 1987).

Bennett et al. (1974) reported chlordane in the top approximately six inches of soil around foundations of two homes 21 years after it was applied as a termiticide. A sampling of soil around 30 houses in Louisiana treated with chlordane showed that chlordane levels varied from 22 to 2,540 ppm (Delaplane and La Fage, 1990). Several studies have reported chlordane concentrations in excess of 10% of the initially applied amount, 10 years or more after application (Beeman and Matsumura, 1981; Lichtenstein and Schulz, 1959; Nash and Woolson, 1967; Stewart and Chisholm, 1971; Stewart and Fox, 1971). A study in Missouri reported greater than 70% of the level of chlordane applied below ground could be accounted for seven years after application (Puri et al. 1990).

Studies have also reported concentrations of chlordane in indoor air in homes 15 years or more after treatment for termites (Livingston and Jones, 1981; Anderson and Hites, 1988). Chlordane has been detected in indoor air in New Jersey (Wright and Leidy, 1982; Fenske and Sternbach, 1987), Indiana (Anderson and Hites, 1988), Massachusetts and Florida (Lewis et al., 1994; Whitmore et al., 1994). A recent study conducted by Offenberg et al. (2004), investigated concentrations of chlordane in indoor and outdoor air in New Jersey, Texas, and California. They reported similar chlordane

concentrations in Los Angeles, California and Houston, Texas, with concentrations slightly lower in Elizabeth, New Jersey.

1.2 Human Health Exposure

Because of its persistence in soils, there is potential for chlordane exposure through direct contact with soils around the foundation of homes where it was applied for termite control. In addition, exposure to chlordane via inhalation may occur through subsurface vapor intrusion to indoor air in homes treated for termites.

1.3 Human Health Effects

Acute effects of chlordane inhalation and oral exposure include gastrointestinal upset and neurological symptoms, such as tremors and convulsions. Chlordane is considered to have high acute toxicity based on short-term animal tests such as the LD₅₀ test in rats. Chronic exposure of humans to chlordane by inhalation results in effects on the nervous, respiratory, and cardiovascular systems and on the liver, blood, and lung. The EPA considers chlordane to be a probable human carcinogen and has classified it as a Group B2 carcinogen (U.S. EPA, 1986). Under the 1996 proposed guidelines, it would be characterized as a likely carcinogen by all routes of exposure (ATSDR, 1994).

Further, the California Office of Environmental Health Hazard Assessment (OEHHA) identified chlordane as one of five of the first chemicals to be evaluated for the development of child-specific reference doses for non-carcinogenic effects (OEHHA, 2003). Chlordane was identified as a chemical that is commonly found at school sites and is of particular concern to children's health, exhibiting toxicity to organ systems that are developing in children, including the immune system, neuroendocrine, and female reproductive systems (OEHHA, 2003).

1.4 Background and Objective of Study

Beginning in January 2000, California legislation now requires school districts to carry out a comprehensive environmental investigation under the oversight of the California Department of Toxic Substances Control (DTSC) to ensure that new schools are built on safe properties. Due to the scarcity of available vacant property in Southern California, school districts are increasingly obligated to obtain residential properties for new schools. In comparison to industrial or commercial sites, residential properties have been expected to pose fewer environmental concerns. DTSC has not routinely evaluated residential properties for potential impacts from organochlorine pesticides. However, based on: 1) the historical widespread application of chlordane in and around homes; 2) the lack of data on pesticide residues at residential and/or commercial properties; 3) the environmental persistence of chlorinated pesticides; and 4) the potential unacceptable risks posed by residual chlordane and other pesticides in soil within residential subdivisions; DTSC now believes further investigation is warranted.

The objective of the Residential Pesticide Study (Study) was to evaluate the prevalence of chlordane and other organochlorine pesticides at levels that would pose a potential threat to human health at several proposed school sites in California. Soil samples were collected at three proposed school sites in Southern California for analysis of organochlorine pesticides. Analytical results were evaluated in a Human Health Screening Evaluation using guidelines established by the DTSC for the preparation of

Preliminary Endangerment Assessments (PEAs) (DTSC, 1999). This risk evaluation is based on the residential or unrestricted land use scenario used by DTSC to evaluate proposed school sites. This Report presents the overall findings of the Study.

2. METHODS

2.1 Study Sites

Three (3) proposed school sites undergoing environmental assessment with DTSC were selected for the Study (Figure 1). The Weemes Elementary School Expansion Site (Weemes) was located in Los Angeles, the Cherokee Point Elementary School Site (Cherokee) was located in San Diego, and the Jones Elementary School Site (Jones) was located in San Bernardino. Historical use of all three sites was residential prior to 1988; there were no historical agricultural, industrial, or commercial uses. Based on the PEA investigation previously conducted at each of the three sites, lead was present in surface soils from the use of lead-based paint.

Technical Memoranda presenting the data collection, analytical results, and recommendations for the Weemes, Cherokee, and Jones proposed school sites are located in Appendix A, B, and C, respectively.

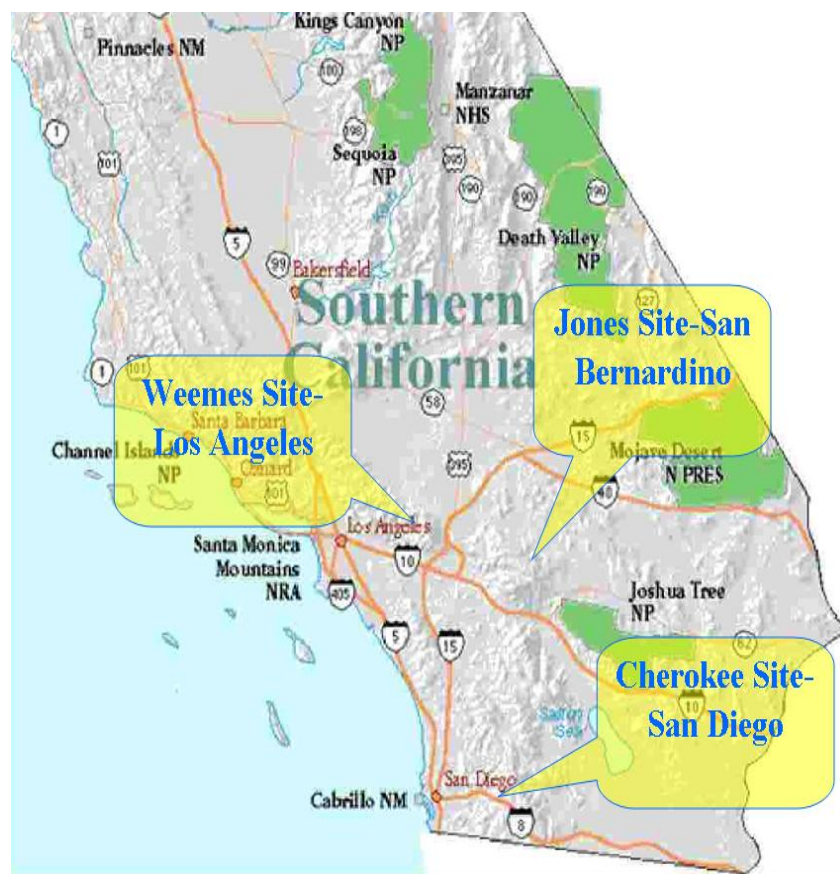


Figure 1
Study Sites

2.2 Sample Collection, Handling, and Analysis

Since organochlorine pesticides were typically applied to the footings and foundation of the homes, soil samples were collected as close as possible to the building perimeters, at or near each of the four corners. The sampling location was relocated away from the corner along the side of the building if pavement obstructed access to soil at the corner. For the surface samples, any existing vegetation on top of the soil was cleared away and the top 0.5 feet of soil was collected using disposable hand trowels. Deeper borings (two and four feet) were advanced using hand auger techniques. Once the sample depth was reached, the hand auger was removed from the boring and grab samples were collected, representing 2.0-2.5 feet below ground surface (bgs) and 4.0-4.5 feet bgs, using disposable hand trowels.

2.2.1 Sample Collection at Weemes (Los Angeles)

The Weemes Site was approximately 0.6 acres and consisted of four residential homes, which were present during sample collection. Forty-seven soil samples were collected at depths of 0-0.5 feet, 2.0-2.5 feet, and 4.0-4.5 feet. Three of the surface samples were taken from crawl-spaces underneath the homes. A total of 47 soil samples were collected at the site: 18 surface samples, 15 two-foot samples, and 14 four-foot samples.

2.2.2 Sample Collection at Cherokee (San Diego)

The Cherokee Site was approximately 7 acres. The Site consisted of 38 former residential homes, all of which had been demolished and the soil grubbed (surface vegetation removed) prior to sample collection. Locations of building footprints were determined from surveys. During the initial sampling event, 32 soil samples were collected from four randomly-selected homes at the site. Samples were collected at depths of 0-0.5 feet and 2.0-2.5 feet only, since refusal was met beyond the two foot samples. During the second sampling event, 20 soil samples were collected at an additional five randomly-selected homes. Only surface soil samples were collected during the second sampling. A total of 52 soil samples were collected at the site: 36 surface samples and 16 two-foot samples.

2.2.3 Sample Collection at Jones (San Bernardino)

The Jones Site was approximately 11 acres and consisted of residential homes, which were present during sample collection. During the initial sampling event, 46 soil samples were collected from four randomly-selected homes at the site. Samples were collected at depths of 0-0.5 feet, 2.0-2.5 feet, and 4.0-4.5 feet. One of the surface samples was collected underneath a front-porch stoop and another was collected underneath a back porch. During a second sampling event, 21 soil samples were collected from an additional five randomly-selected homes. Only surface soil samples were collected during the second sampling; one of these samples was collected underneath a stoop. A total of 67 soil samples were collected at the site: 38 surface samples, 15 two-foot samples, and 14 four-foot samples.

2.2.4. Quality Control Samples

Field duplicate soil samples and an equipment blank water sample were collected during each sampling event. A total of 10 field duplicate soil samples and five equipment blank

water samples were collected. Laboratory control samples, matrix spikes, matrix spike duplicates, and method blanks were analyzed with each batch of soil samples. Analytical results and data validation are presented for the three sites in Appendices A, B, and C. All data were validated to Level IV according to the National Functional Guidelines (U.S. EPA, 1994).

3.0 ANALYTICAL RESULTS

During the Study, a total of 176 soil samples (including duplicate samples) were collected from three sites and analyzed for organochlorine pesticides by EPA Method 8081A at a State of California-certified contract laboratory. Table 1 summarizes the number of samples collected by depth at each of the three school sites. The frequency of detection of organochlorine pesticides at each site are presented separately below, followed by all sites combined.

Table 1
Number of OCP Samples by Depth

School Site	Number of Samples Collected 0.5-feet	Number of Samples Collected 2-feet	Number of Samples Collected 4-feet
Weemes	18	16	15
Jones	41	15	15
Cherokee	39	17	0

3.1 Weemes (Los Angeles)

Analytical results for Weemes are presented in Appendix A. Table 2 presents a summary of organochlorine pesticide detections. The highest concentration of each pesticide was detected in surface soil samples (0- to 0.5-feet bgs). In surface soil samples, chlordane and 4,4'-DDT were detected in each sample, at all four homes, including the two crawlspace samples (i.e., the detection frequency was 100%). At 2- and 4-feet bgs, only low levels of chlordane, 4,4'-DDD, 4,4'-DDE and 4,4'-DDT were detected. The OCPs detected, the reported soil concentration and the frequency of detection all substantially decrease with depth.

Table 2
Summary of OCP Detections at Weemes

OCP Detected	Maximum Concentration (mg/kg)	Detection Frequency 0.5-feet	Detection Frequency 2-feet	Detection Frequency 4-feet
Chlordane	36	18/18 (100%)	4/15 (27%)	4/14 (29%)
4,4'-DDD	1.1	15/18 (83%)	3/15 (20%)	1/14 (7%)
4,4'-DDE	1.4	16/18 (89%)	3/15 (20%)	1/14 (7%)
4,4'-DDT	16	18/18 (100%)	5/15 (33%)	2/14 (14%)
Dieldrin	2.7	12/18 (67%)	0/15 (0%)	0/14 (0%)

Endosulfan I	0.6	1/18 (6%)	0/15 (0%)	0/14 (0%)
Endrin	0.08	1/18 (6%)	0/15 (0%)	0/14 (0%)
Endrin Aldehyde	0.5	1/18 (6%)	0/15 (0%)	0/14 (0%)
Heptachlor	0.5	6/18 (33%)	0/15 (0%)	0/14 (0%)
Heptachlor Epoxide	0.1	5/18 (28%)	0/15 (0%)	0/14 (0%)
Lindane	0.1	2/18 (11%)	0/15 (0%)	0/14 (0%)

3.2 Cherokee (San Diego)

Analytical results for Cherokee are presented in Appendix B. Table 3 presents a summary of organochlorine pesticide detections. As at Weemes, the highest concentration of each pesticide was detected in surface soil samples (0- to 0.5-feet bgs). Chlordane, 4,4'-DDE, and 4,4'-DDT were detected at the greatest frequency: 95%, 95%, and 97%, respectively. At 2-feet bgs only low levels of chlordane, 4,4'-DDD, 4,4'-DDE, 4,4'-DDT and dieldrin were detected. No samples were collected at 4-feet bgs.

Table 3
Summary of OCP Detections at Cherokee

OCP Detected	Maximum Concentration (mg/kg)	Detection Frequency 0.5-feet	Detection Frequency 2-feet
Aldrin	0.005	1/39 (3%)	0/17 (0%)
Chlordane	4.2	37/39 (95%)	8/17 (47%)
4,4'-DDD	0.7	17/39 (44%)	3/17 (18%)
4,4'-DDE	2.7	37/39 (95%)	7/17 (41%)
4,4'-DDT	5.3	38/39 (97%)	7/17 (41%)
Dieldrin	0.2	27/39 (69%)	7/17 (41%)
Heptachlor	0.5	1/39 (3%)	0/17 (0%)
Heptachlor Epoxide	0.004	5/18 (28%)	0/17 (0%)
Lindane	0.01	1/39 (3%)	0/17 (0%)

3.3 Jones (San Bernardino)

Analytical results for Jones are presented in Appendix C. Table 4 presents a summary of organochlorine pesticide detections. As at both Weemes and Cherokee, the highest concentration of each pesticide detected in surface soil samples (0- to 0.5-feet bgs). Chlordane, 4,4'-DDE, and 4,4'-DDT were detected at the greatest frequency: 95%, 86%, and 88%, respectively. At 2- and 4-feet bgs, only low levels of chlordane, 4,4'-DDE, 4,4'-DDT and dieldrin were detected.

Table 4
Summary of OCP Detections at Jones

OCP Detected	Maximum Concentration (mg/kg)	Detection Frequency 0.5-feet	Detection Frequency 2-feet	Detection Frequency 4-feet
Chlordane	336	40/42 (95%)	8/15 (53%)	6/15 (40%)
4,4'-DDD	4.5	13/42 (31%)	0/15 (0%)	0/15 (0%)
4,4'-DDE	3.4	36/42 (86%)	5/15 (33%)	3/15 (20%)
4,4'-DDT	9.7	37/42 (88%)	4/15 (27%)	3/15 (20%)
Dieldrin	24	31/42 (74%)	9/15 (60%)	4/15 (27%)
Endrin	0.005	1/42 (2%)	0/15 (0%)	0/15 (0%)
Heptachlor	0.9	10/42 (24%)	0/15 (0%)	0/15 (0%)
Heptachlor Epoxide	0.8	4/42 (10%)	0/15 (0%)	0/15 (0%)
Lindane	0.04	3/42 (7%)	0/15 (0%)	0/15 (0%)

3.4 Combined Organochlorine Pesticide Dataset

Table 5 presents the frequency of detection by depth for the combined OCP dataset for all three school sites. The OCPs most frequently detected were chlordane, DDT, DDE, DDD and dieldrin.

Table 5
Summary of Detection Frequencies- All Sites Combined

OCP Detected	Detection Frequency 0.5-feet	Detection Frequency 2-feet	Detection Frequency 4-feet
Aldrin	1/98 (1%)	0/48 (0%)	0/30 (0%)
Chlordane	96/98 (98%)	20/48 (42%)	10/30 (33%)
DDD	45/98 (46%)	6/48 (13%)	1/30 (3%)
DDE	89/98 (91%)	15/48 (31%)	4/30 (13%)
DDT	93/98 (95%)	17/48 (35%)	5/30 (17%)
Dieldrin	70/98 (71%)	16/48 (33%)	4/30 (13%)
Endosulfan I	1/98 (1%)	0/48 (0%)	0/30 (0%)
Endrin	2/98 (2%)	0/48 (0%)	0/30 (0%)
Endrin Aldehyde	1/98 (1%)	0/48 (0%)	0/30 (0%)
Heptachlor	17/98 (17%)	0/48 (0%)	0/30 (0%)
Heptachlor Epoxide	9/98 (9%)	0/48 (0%)	0/30 (0%)
Lindane (γ-HCH)	6/98 (6%)	0/48 (0%)	0/30 (0%)

4.0 HUMAN HEALTH SCREENING EVALUATION

This section presents the Human Health Screening Evaluation for organochlorine pesticides detected in soil. The human health screening evaluation utilizes maximum

concentrations of identified chemicals of potential concern (COPCs) to estimate contaminant intakes through the ingestion, dermal contact and inhalation routes of exposure. These estimated chemical intakes are evaluated for potential carcinogenic risks and noncarcinogenic health hazards using health-based toxicity criteria developed by the U.S. EPA and OEHHA. This human health screening evaluation is used by DTSC to evaluate proposed school sites based on a residential (unrestricted) land use scenario.

4.1 Exposure Pathways and Media of Concern

Using DTSC Guidance for performing human health evaluations as part of a PEA (DTSC, 1999), it was assumed that each site was completely uncovered and soils were available for direct contact. Three pathways of exposure were considered: ingestion of soil, dermal contact with soil, and inhalation of suspended soil particulates. Consistent with PEA Guidance, health effects were conservatively evaluated for a residential receptor. Estimated carcinogenic risks were evaluated for a combined child and adult over an assumed 30-year exposure period. Noncarcinogenic health effects were evaluated for a child, with maximum potential exposures.

4.1.1 Soil Exposure Pathways

COPCs in soil include organochlorine pesticides. Potential residential exposure to organochlorine pesticides was evaluated through incidental ingestion and dermal contact. Exposures by these two routes were estimated according to the equations shown in Appendix D.

4.1.2 Water Exposure Pathways

Groundwater impacts at the three proposed school sites were considered extremely unlikely and the groundwater pathway was not evaluated further in this human health screening assessment.

4.1.3 Air Exposure Pathways

Potential residential exposure to organochlorine pesticides detected in soil was evaluated for inhalation of suspended soil particulates. Exposure through the inhalation route was estimated according to the equation shown in Appendix D.

4.2 Exposure Concentrations and Chemicals

For the purposes of this human health screening evaluation, potential carcinogenic risks and noncarcinogenic health hazards were estimated 1) for surface soils using the maximum reported soil concentrations detected on-site; and 2) for subsurface soils at 2-feet and 4-feet bgs, in order to assist decision-makers regarding the depth of future soil removal.

4.3 Toxicity Values

Toxicity values are used to characterize the relationship between the exposure to an agent and the incidence of adverse health effects in exposed populations. In a quantitative carcinogenic risk assessment, the dose-response relationship of a

carcinogen is expressed in terms of a slope factor (oral) or unit risk (inhalation), which are used to estimate the probability of risk of cancer associated with a given exposure pathway. Cancer slope factors and unit risk factors as published by Cal-EPA (01/2003) and EPA (Integrated Risk Information System (IRIS)) were used in this human health risk assessment.

For noncarcinogenic effects, toxicity data developed from animal or human studies are typically used to develop noncancer acceptable levels, or reference doses (RfDs). A chronic reference dose is defined as an estimate of a daily exposure for the human population, including sensitive subpopulations, that is likely to be without appreciable risk of deleterious effects during a lifetime. The oral chronic reference doses, as published in IRIS or EPA's Health Effects Assessment Summary Tables (HEAST), were used in this evaluation. Inhalation reference doses were calculated from the Cal/EPA Reference Exposure Levels (RELs), as published by the Office of Environmental Health Hazard Assessment (OEHHA, 2001). If an REL was unavailable for a particular chemical, the inhalation reference dose from IRIS or HEAST was used.

4.4 Risk Characterization Summary

Risk characterization is the process used to assess the potential carcinogenic risk and noncarcinogenic health hazards for the populations of concern represented by the chemical contaminants in soil at the site. Potential carcinogenic effects were estimated from the predicted intakes and chemical-specific dose-response information. Potential noncarcinogenic effects were estimated by comparing the predicted intakes of COPCs to their respective toxicity criteria (i.e., inhalation reference doses (RfD_i)).

4.4.1 Noncarcinogenic Health Effects for Soil Contaminants

In order to estimate the potential effects from exposure to multiple COPCs, the hazard index (HI) approach was used. The HI is defined as the summation of the hazard quotients for each COPC, for each route of exposure, and is represented by the following equation:

$$HI = \frac{\text{Predicted Dose}_a}{RfD_a} + \frac{\text{Predicted Dose}_b}{RfD_b} + \dots + \frac{\text{Predicted Dose}_i}{RfD_i}$$

A total HI less than or equal to unity is indicative of acceptable levels of exposure for chemicals assumed to exhibit additive health effects. To be truly additive in effect, chemicals must affect the same target organ system or result in the same critical toxic endpoint. A HI less than or equal to 1.0 suggests that adverse health effects would not be expected following a lifetime of exposure, even in sensitive members of the population.

4.4.2 Carcinogenic Health Effects for Soil Contaminants

Quantitative estimates of upper-bound incremental cancer risk due to site-related contamination were evaluated for each COPC according to the following equation:

$$R_i = \text{Intake}_i \times SF_i$$

Where,

- R_i = Estimated incremental risk of cancer associated with the i th chemical
- Intake_i = Intake or lifetime average daily dose for the i th chemical, mg/kg-day
- SF_i = Cancer slope factor for the i th chemical, (mg/kg-day)⁻¹

Carcinogenic risk was assumed to be additive and was estimated by summing the upper-limit incremental cancer risk for all carcinogenic COPCs.

4.5 Site Specific Risks and Hazards

4.5.1 Weemes (Los Angeles)

The residential hazard index for exposure to maximum reported concentrations of pesticides in surface soil at Weemes was 2.6, which is above the DTSC level of concern (HI = 1) and indicative of potential adverse health effects from exposure to site soils. This estimated hazard was primarily attributable to chlordane (approximately 41% of the total hazard), dieldrin (approximately 31% of the total hazard), 4,4'-DDT (approximately 18% of the total hazard) and heptachlor/heptachlor epoxide (approximately 5% of the total hazard).

The total excess carcinogenic risk from ingestion of surface soil, dermal contact with surface soil, and inhalation of suspended surface soil particulates was 1.7×10^{-4} . This risk is above the DTSC point of departure (i.e., a risk of one-in-one-million or 1×10^{-6}), and is outside of the risk management range defined by regulatory agencies (1×10^{-6} to 1×10^{-4}). Consequently, the total site risk would be considered unacceptable under an unrestricted, residential land use scenario. This estimated risk was primarily attributable to chlordane (approximately 47% of the total risk) and dieldrin (approximately 44% of the total risk).

The residential hazard index associated with exposure to subsurface soils was 0.03, which is well below the DTSC level of concern. The total excess cancer risk associated with exposure to subsurface soils was 7.7×10^{-7} , which is below the DTSC point of departure and below the lower end of the risk management range. Based on the above results, unacceptable carcinogenic risk and noncarcinogenic health hazards would only be associated with site soils between 0- and 2-feet bgs. No adverse health effects would be expected from unlimited exposure to subsurface soils (2- to 4-feet bgs).

4.5.2 Cherokee (San Diego)

The residential hazard index for exposure to maximum reported concentrations of pesticides in surface soil at Cherokee was 0.4, which is below the DTSC level of concern (HI = 1), and indicative of no potential adverse health effects from exposure to site soils. This estimated hazard was primarily attributable to chlordane (approximately 41% of the total hazard), dieldrin (approximately 15% of the total hazard), and 4,4'-DDT (approximately 35% of the total hazard).

The total excess carcinogenic risk from ingestion of surface soil, dermal contact with surface soil, and inhalation of suspended surface soil particulates at Cherokee was $2.2 \times$

10^{-5} . This risk is above the DTSC point of departure (i.e., a risk of one-in-one-million or 1×10^{-6}), but within the risk management range defined by regulatory agencies (1×10^{-6} to 1×10^{-4}). Consequently, the total site risk is considered unacceptable under an unrestricted, residential land use scenario. This estimated risk was primarily attributable to chlordane (approximately 45% of the total risk), dieldrin (approximately 30% of the total risk), 4,4'-DDT (approximately 15% of the total risk) and 4,4'-DDE (approximately 8% of the total risk).

The residential hazard index associated with exposure to subsurface soils at Cherokee was 0.09, which is well below the DTSC level of concern. The total excess cancer risk associated with exposure to subsurface soils was 6×10^{-6} , which is above the DTSC point of departure but well within the risk management range. Based on the above results, unacceptable carcinogenic risk is only associated with site surface soils between 0- and 0.5-feet bgs.

4.5.3 Jones (San Bernardino)

The residential hazard index for exposure to maximum reported concentrations of pesticides in surface soil at Jones was 18.4, which is well above the DTSC level of concern (HI = 1), and indicative of potential adverse health effects from exposure to site soils. This estimated hazard was primarily attributable to chlordane (approximately 54% of the total hazard) and dieldrin (approximately 38% of the total hazard).

The total excess carcinogenic risk from ingestion of surface soil, dermal contact with surface soil, and inhalation of suspended surface soil particulates at Jones was 1.5×10^{-3} . This risk is well above the upper end of the risk management range defined by regulatory agencies (1×10^{-6} to 1×10^{-4}). Consequently, the total site risk is considered unacceptable under an unrestricted, residential land use scenario. This estimated risk was primarily attributable to chlordane (approximately 52% of the total risk) and dieldrin (approximately 46% of the total risk).

The residential hazard index associated with exposure to soils at 2-feet bgs was 0.07, which is well below the DTSC level of concern. The total excess cancer risk associated with exposure to subsurface soils was 6×10^{-6} , which is slightly above the DTSC point of departure but well within the risk management range.

The residential hazard index associated with exposure to soils at 4-feet bgs was 0.02, which is well below the DTSC level of concern. The total excess cancer risk associated with exposure to subsurface soils was 2×10^{-6} , which is slightly above the DTSC point of departure but well within the risk management range.

4.6 Discussion of Risk Assessment Results

From the site-specific risk summaries presented in Sections 4.5.1 through 4.5.3, site risks were primarily driven by two OCPs at each of the three sites, namely chlordane and dieldrin. The most frequently detected OCPs appear to be lognormally distributed. To graphically present the data, the individual and combined data sets were lognormally transformed and the data were plotted as probability distributions, also known as normality plots.

Figure 2 presents the normality plot of the chlordane data for the combined data set of 176 samples from all three proposed school sites. In order to visualize the risk for each sample point, the risk management range for chlordane was overlaid on the normality plot. The chlordane data were presented as combined surface and subsurface data (LOGCHLORALL), surface data (LOGCHLORSURF), chlordane data at 2-feet bgs (LOGCHLOR2) and chlordane data at 4-feet bgs (LOGCHLOR4).

Risks attributed to chlordane were primarily associated with surface soils (0- to 0.5-feet bgs). Approximately 50% of the chlordane detection at 0.5-feet bgs were above a 1×10^{-6} risk. Approximately 19% of the chlordane detections at 0.5-feet bgs were above a 1×10^{-5} risk. Only 4% of the chlordane detections at 2-feet or below were above a 1×10^{-6} risk.

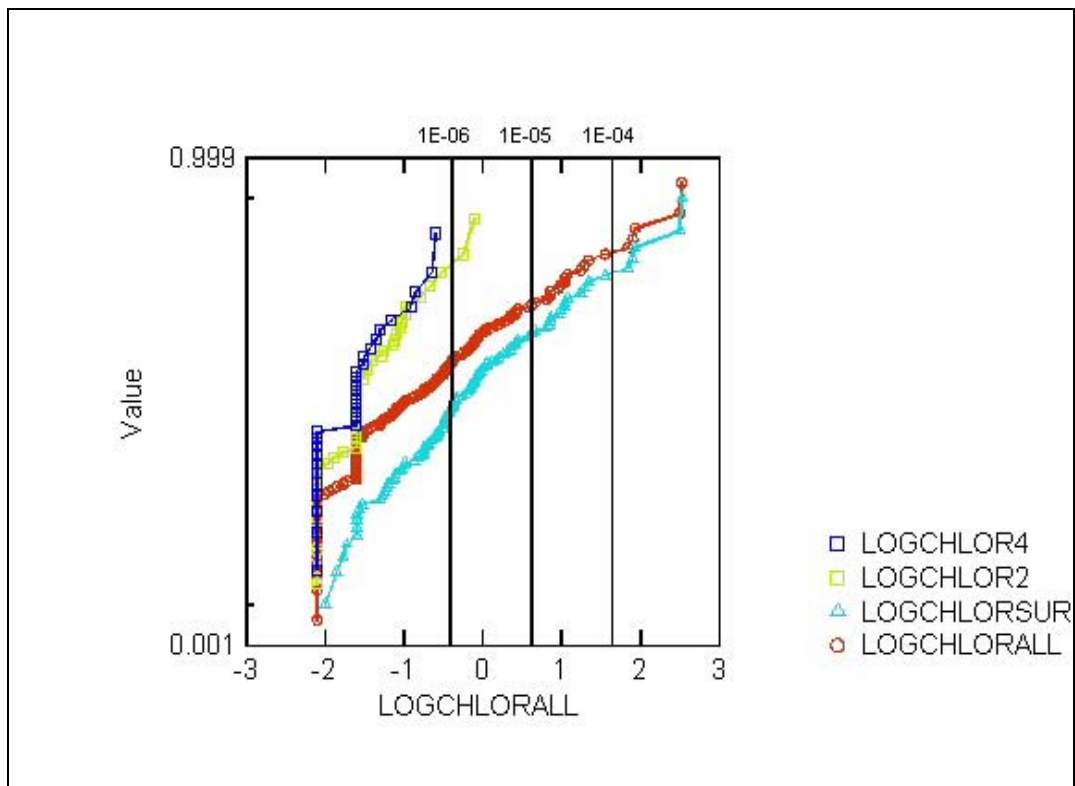


Figure 2
Normality Plot of Chlordane Data, Combined Data Set

Figure 3 presents the normality plot of chlordane detected in surface soil for each of the three proposed school sites. The slope of the chlordane data from the Cherokee Site differs substantially from the other two school sites in that risks based on chlordane concentrations at Cherokee are notably lower than the risks based on concentrations detected at Jones and Weemes.

Both the Weemes and Jones sites were sampled prior to building demolition, while the Cherokee site was sampled after the buildings were demolished and the soil graded. Consequently, the chlordane concentrations in soil at Cherokee were likely diluted by mixing and re-distribution. Even so, 36% of the surface soil chlordane risks at the Cherokee site were above 1×10^{-6} . These results may indicate sampling for organochlorine pesticides can be conducted either pre- or post-demolition, since concentrations which posed unacceptable risks will be detected by either sampling scheme. More research is needed to support this assumption.

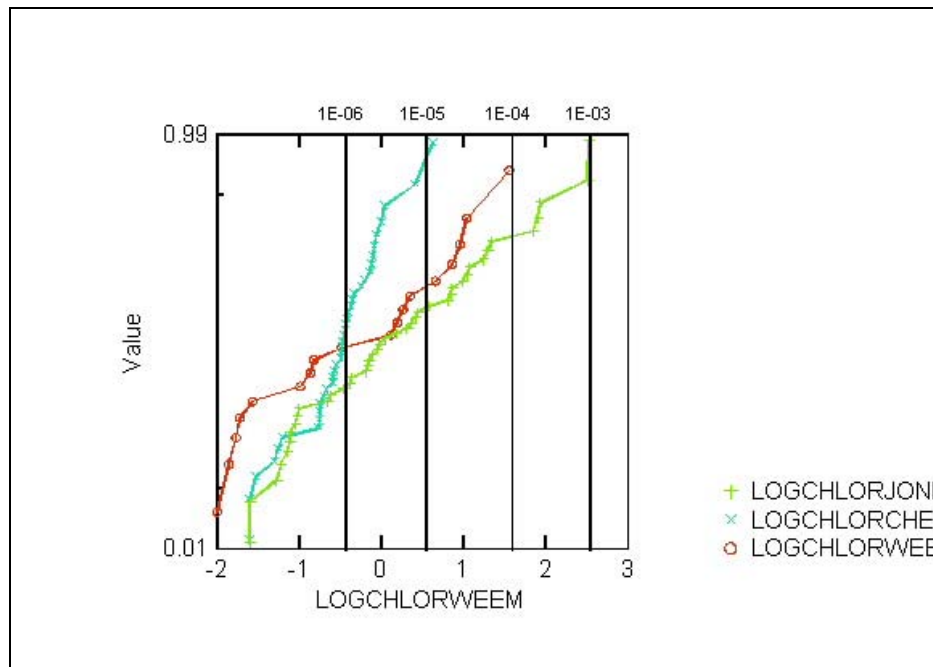


Figure 3
Chlordane in Surface Soil by School Site

Figure 4 presents the normality plot of the dieldrin data for the combined data set of 176 samples from all three proposed school sites overlaid by the risk management range for dieldrin. The dieldrin data were presented as combined surface and subsurface data (LOGDIELDALL), surface data (LOGDIELDSURF), dieldrin data at 2-feet bgs (LOGDIELD2) and dieldrin data at 4-feet bgs. (LOGDIELD4).

The dieldrin dataset is very similar to the chlordane dataset, with risks from dieldrin primarily associated with surface soils (0- to 0.5-feet bgs). Approximately 47% of the dieldrin detections at 0.5-feet bgs were above a 1×10^{-6} risk. Approximately 18% of the dieldrin detections at 0.5-feet bgs were above a risk of 1×10^{-5} . Only 8% of the chlordane detections at 2-feet or below had a risk above 1×10^{-6} .

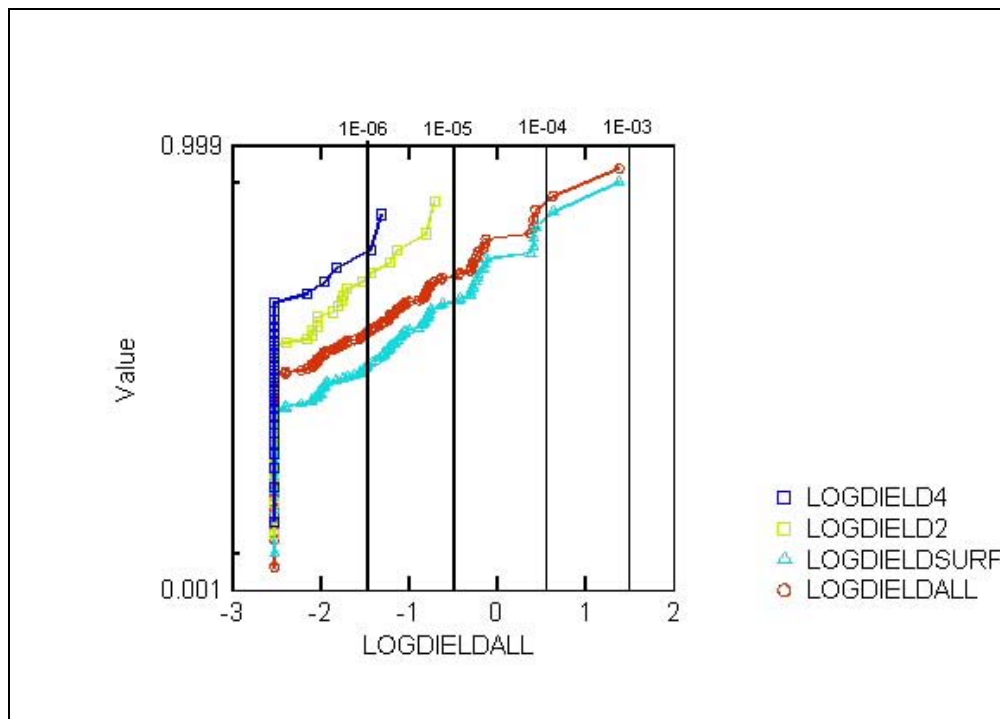


Figure 4
Normality Plot of Dieldrin Data, Combined Data Set

Figure 5 presents the normality plot of dieldrin detected in surface soil for each of the three proposed school sites. Again, the same pattern was observed as for chlordane.

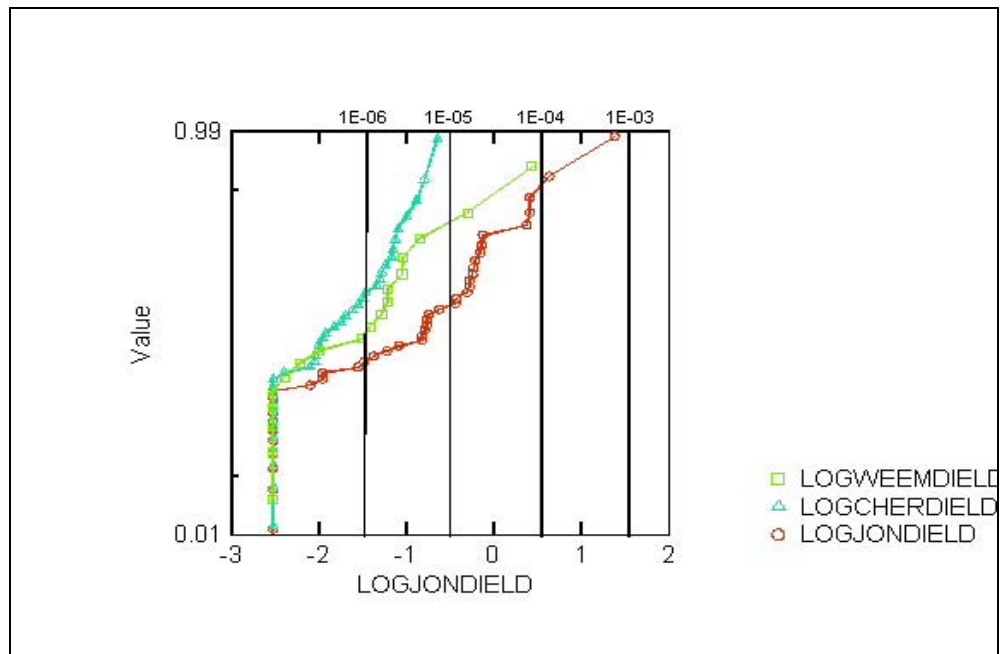


Figure 5
Dieldrin in Surface Soil by School Site

The next two highest contributors to site risks from OCPs were DDT and DDE. Figures 6 and 7 present the normality plots of the combined data sets for DDT and DDE, respectively. The “x” in the figures represents the log concentration resulting in a risk of 1×10^{-5} . Approximately 6% of the DDT detections and 2% of the DDE detections at 0.5-feet bgs were above a risk of 1×10^{-5} . Only one DDT detection at 0.5-feet exceeded a risk of 1×10^{-5} . No DDT or DDE detections at 2-feet exceeded a 1×10^{-6} risk.

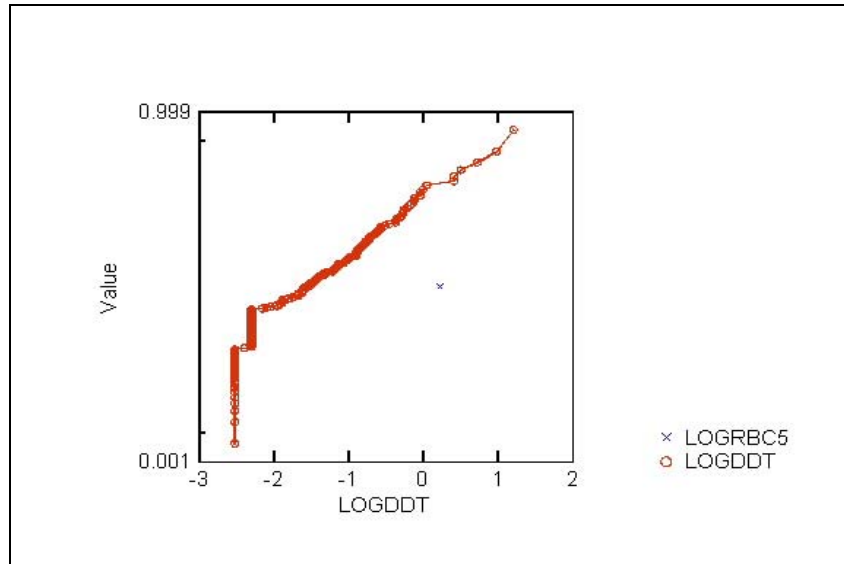


Figure 6
Normality Plot of DDT Data, Combined Data Set

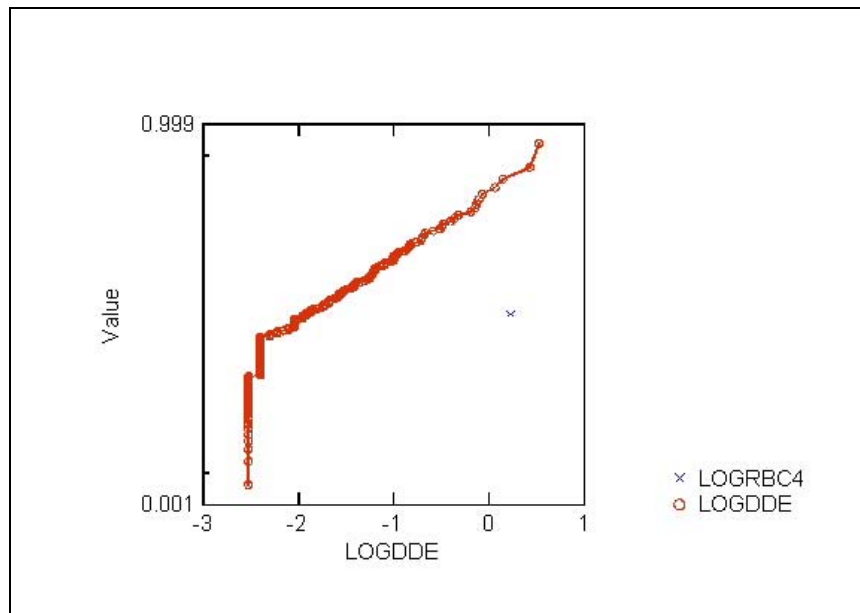


Figure 7
Normality Plot of DDE Data, Combined Data Set

5.0 SUMMARY AND CONCLUSIONS

Soil samples were collected from three proposed school sites in Southern California. All three sites were historically used for residential properties. A total of 176 soil samples were collected at three depths around the perimeter of the residential structures at two sites; samples were collected at two depths around the footprint of residential structures that had been demolished at one site. Samples were analyzed for organochlorine pesticides by EPA Method 8081A.

Organochlorine pesticides were most frequently detected in surface soils (0-0.5 feet bgs). The following organochlorine pesticides were detected at the greatest frequency in surface samples: chlordane (98%), DDT (95%), DDE (91%), and dieldrin (71%).

Based on a Human Health Screening Evaluation, carcinogenic risk and non-carcinogenic hazard was calculated for each detected organochlorine pesticide. Results indicate elevated site risks and hazards were primarily associated with chlordane and dieldrin in surface soils. Approximately 50% of chlordane and dieldrin detections had an associated risk above 1×10^{-6} , and approximately 20% of chlordane and dieldrin detections had an associated risk above 1×10^{-5} .

These findings indicate a high frequency of organochlorine pesticide (OCP) detections in surface soils around residential structures in three locations in Southern California. Further, the levels of OCPs detected present a potential unacceptable risk to children and adults under a residential, unrestricted land use scenario.

6.0 RECOMMENDATIONS

Results of this Study indicate there is potential for organochlorine pesticides to be present in soil at residential properties at levels that would pose a risk to students and adults under an unrestricted land use scenario. Based on these results, DTSC recommends sampling and analysis for organochlorine pesticides be routinely performed at proposed school sites historically used for residential properties.

Sampling may be conducted in conjunction with the current protocol for investigation of lead in soil from lead based paint (DTSC, 2001). As with sampling for lead, initial sampling for OCPs can be limited to collection of four (4) surface soils around the perimeter of the structures. Analysis for OCPs can be performed on splits of soil samples already being collected for lead analysis. Based on results of the Human Health Screening Evaluation, further investigation, including additional sampling at lateral and vertical intervals from the original samples, may be required.

As with the current regulations that allow the inclusion of results of testing for lead and polychlorinated biphenyls in Phase I Environmental Site Assessments for proposed school sites, organochlorine pesticide investigation results may be presented in a Phase I Addendum for the site. This will require the development of risk-based screening concentrations for OCPs by the DTSC Human and Ecological Risk Division, modification of existing DTSC guidance on sampling for lead-based paint (DTSC, 2001), as well as changes in the existing regulations on content of a Phase I or Phase I Addendum prepared for a proposed school site.

7.0 LIMITATIONS

This study is limited in its focused approach. While only residential structures were sampled, organochlorine pesticides were likely also applied to commercial structures of similar age. Future studies should include sampling of commercial structures. Additional investigation should also include sites in Northern California to allow for potential differences in application and persistence of pesticides based on differences in insect populations, type of building materials, soil types, and climate.

Based on results at the Cherokee Site, where structures had been demolished and the Site graded prior to sampling, unacceptable risks were detected even though soil was disturbed and organochlorine pesticides likely diluted. This suggests sampling can be conducted either pre- or post-demolition, although more research is needed to substantiate this assumption.

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